Next Generation Computer Resources (NGCR)
NGCR Document No. AST 003 ver. 1.0
31 December 1996

Open Systems

Acquisition
&
Supportability

Guide

Space and Naval Warfare Systems Command
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PREFACE

The *Open Systems Acquisition & Supportability Guide* summarizes and provides information gained through both the Navy's Next Generation Computer Resources (NGCR) program and early Navy users of commercially based open systems. The primary goal is to help Navy programs to plan and implement open systems in a cost effective manner. When the NGCR program was initially founded, many people said "we will never use open standards for warfare systems". However, open standards usage is current DoD policy and program offices are learning the benefits of applying an open systems approach to achieve an architectural foundation for system upgrade and development. Discussions continue as to definitions for specific terms but overall open systems concepts and goals are now widely accepted.

The information base provided by this Guide is not meant to be all inclusive. Rather, it is meant to provide a starting point for program specific planning. Tailoring and adding to the questions and concepts presented in this Guide is appropriate and recommended to identify and meet external and internal program needs. Experience will add to the information on open systems and provide more data for future acquisition and support planning.

The initial draft of the *Open Systems Computer Resources Acquisition Guide* was published in April 1995. The draft of the *Open Systems Computer Resources Supportability Guide* was published in September 1995. Both documents were well received and used as foundation material for program planning of efforts to develop, upgrade, and support Navy and other mission critical government systems. This Guide combines, clarifies, and expands the information of both of these documents.

It is time to move on and to thank those hardy souls who first saw the light and helped the rest of us to do so. Participants in the development of this document are too numerous to list here. Contributions came from people from the Department of the Navy, other Department of Defense (DoD) elements, industry, and academia. Some people and organizations participated in development of the initial draft *Open Systems Computer Resources Acquisition Guide*. Other people participated in development of the *Open Systems Computer Resources Supportability Guide*. Particular thanks are hereby expressed to Karl McClure, Larry Holtzman, and Mark Chestnutwood at the Naval Surface Warfare Center, Crane Indiana; to Don Ross at the Naval Air Warfare Center - Aircraft Division, Indianapolis; and to John Brinkheide, Cari Dorman, and Dale Anderson from Computer Sciences Corporation. This group contributed their impressive weapons system, C4I, systems engineering, and other appropriate experience bases. They dissected and reassembled relevant information into what we hope is a useful tool for program offices and the organizations which support them. Thanks to all of you.

Alexander Lewin

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1.0 INTRODUCTION

1.1 Purpose and Audience

The purpose of this Guide is to provide program managers, their staffs, supporting warfare centers, laboratories, and contractors with a framework of open system acquisition and supportability planning knowledge. This knowledge, tailored for specific program usage, will enable them to:

- identify and address issues and considerations which are unique or more prevalent in an open system acquisition, and
- work together comfortably and cost effectively to transition from use of Department of Defense (DoD) unique interfaces to commercially based open architectures.

1.2 Scope

This Guide addresses many, but certainly not all, of the issues present in moving Navy weapon and Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) systems from proprietary closed architectures to open interface standards based solutions and their respective acquisition and supportability needs.

Also addressed are many of the issues which stem from the need for Joint operations and interoperability. Requirements are addressed in directives such as: DoDD 4630.5, Compatibility, Interoperability, and Integration of C3I Systems, dated 12 Nov 92, which stipulates that "...all C3I systems developed for use by U.S. forces are considered to be for Joint use." and DoDI 4630.8, Procedures for Compatibility, Interoperability, and Integration of C3I Systems, dated 18 Nov 92, which states that "...DISA, shall certify.....that C3I systems and equipment meet the

This Guide uses short narrative descriptions, figures, tables, process, and topic oriented discussions to provide:

- important open systems terms, concepts, and major transition issues to be considered when acquiring open systems,
- an acquisition/systems engineering process oriented view,
- topic oriented discussions of supportability functions, and
- topic oriented discussions of various tools and methods.

1.3 Source

The information presented in this Guide was gathered from various Navy programs which are upgrading legacy systems or creating new systems on an architectural foundation of commercial open interface standards.

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2.0 UNDERSTANDING OPEN SYSTEMS

Procurement of open system designs for DoD system applications represents a significant change in DoD acquisition and support methodology. Designing military systems based on open architectures and interface standards makes economic sense for DoD in today's environment of rapidly evolving commercially-based technologies and declining budgets. The need to upgrade systems in a modular, cost-effective, best value manner has never been greater. Using widely-accepted commercial interface standards as opposed to standards unique to the military provides the added cost-avoidance benefits of leveraging a large market base.

The open systems approach mandated by DoD policy encompasses the selection of specifications and standards adopted by industry standards bodies or *de facto* standards for selected system interfaces, products, practices, and tools. Open systems standards define interfaces which support portability, interoperability, and scaleability (i.e., expansion); and that are available to the public. An open systems standard is primarily concerned with interface compatibility. The use of open system interface standards:

- promotes interoperability between multiple suppliers' equipment,
- does not imply or assure the existence of interchangeable products from different sources,
- promotes both initial competition among products and competitive upgrade opportunities; thus the ability to reduce costs though competition is promoted, and
- promotes but is not synonymous with commercial item products.

To gain advantages from open standards usage, it is imperative that program management offices have an understanding of the objectives, requirements, and approaches necessary to achieve an open system environment (OSE). This section of the Guide contains discussions of:

- open systems concepts and terms,
- standards and standards bodies, and
- major transition issues, such as
  - DoD initiatives and requirements,
  - risk management,
  - quality assurance,
  - software engineering.

Some key system objectives of an OSE are listed below.

KEY OSE OBJECTIVES
✓ Reduction of Life Cycle Costs (LCC), especially supportability and maintainability
✓ Interoperability between two or more systems or products
✓ Sharing of common application support resources
✓ Portability
✓ Optimum reuse of hardware and software components
✓ Elimination of interface uniqueness
✓ Plug and play environment
✓ Elimination of redundant procurement of functional capabilities
✓ Increase sources of supply and vendor competition
✓ Improve technology insertion opportunities
✓ Provide stable upgrade paths for technology and modularity of products

2.1 Definitions

The term *open system* has many definitions and interpretations (table 2-1). Though the various definitions have common elements, no formal agreement on any one definition exists. This section discusses the main factors of several of these definitions, along with the notion of standards and standards bodies that together support an OSE.

OPEN SYSTEM	
SOURCE	**DEFINITION**
Open Systems Joint Task Force (OSJTF) and Technical Architecture Framework for Information Management (TAFIM)	A system that implements sufficient open specifications for interfaces, services, and supporting formats to enable properly engineered applications software: (a) to be ported with minimal changes across a wide range of systems, (b) to interoperate with other applications on local and remote systems, and (c) to interact with users in a style that facilitates user portability. [IEEE P1003.0/D15]
IEEE P1003.0, Draft 16 (POSIX)	"A system that implements sufficient open specifications or standards for interfaces, services and supporting formats to enable properly engineered applications software: • To be ported with minimal changes across a wide range of systems • To interoperate with other applications on local and remote systems To interact with people in a style that facilitates user portability."
NGCR and Tri-Service Open System Architecture Working Group	"A system that implements sufficient open specifications for interfaces, services, and support formats to enable properly engineered components to be utilized across a wide range of systems with minimal changes to interoperate with other components on local and remote systems, and to interact with users in a style which facilitates portability. An *open system* is characterized by the following: • Well defined, widely used non-proprietary interfaces/protocols, • Use of standards which are developed/adopted by industrially recognized standards bodies • Definition of all aspects of system interfaces to facilitate new or additional systems capabilities for a wide range of applications • Explicit provision for expansion or upgrading through the incorporation of additional or higher performance elements with minimal impact on the system."

Software Engineering Institute (SEI) at
Carnegie-Mellon
University
	" An *open system* is:
	• A collection of interacting software, hardware, and human components
	• Deigned to satisfy stated needs
	• With the interface specification of components
	    • Fully defined and available to the public
	    • Maintained according to group consensus, and
	• In which the implementations of components are conformant to the specification."

Faulkner Information Services	" a set of standards that enable users to select system and network components from a broad range of suppliers to suit individual application requirements while preserving a homogeneous information system infrastructure."
Gary Nutt, *Open Systems*	"...components and their composition are specified in a non-proprietary environment, enabling competing organizations to use these standard components to build competitive systems."
Pamela Gray, *Open Systems, A Business Strategy for the 1990s*	"When the three characteristics: portability, scaleability, and interoperability, are taken together, and international standards set for them by an open process, in which anyone may participate, and the results are available on equal terms to all, the result is to define that part of the computer industry known as 'open systems'."

Table 2-1 Open System Definitions

Each definition in table 2-1 strikes a particular group as correct or incorrect, complete or incomplete. However, the key commonalties in most open system definitions are producer independent (hereafter referred to as original equipment manufacturer (OEM)), non-proprietary, publicly available, and widely accepted. Ideally, open systems represent a transparent environment in which users can intermix hardware, software, and networks of different vintages from different OEMs to meet differing needs. Other properties exhibited in an open system are:

- *Interchangeable* **-** (1) Capable of being interchanged; *esp.*: permitting mutual substitution <~ parts>. [Webster's Dictionary] (2) The ability of two or more products (hardware or software) to be transparent replacements for one another without other hardware, software, firmware, or wiring changes. [this Guide]

- *Interoperability* **-** (1) The ability of the systems, units, or forces to provide and receive services from other systems, units, or forces, and to use the services so interchanged to enable them to operate effectively together. [Joint Pub 1-02, DoD/NATO] [JOPES ROC] {TAFIM}

- *Portability* - (1) The ability of two or more systems or components to exchange and use information. [IEEE STD 610.12] (2) The ease in which a system or component can be transferred from one hardware or software environment to another. [IEEE Std 610.12] (3) A quality metric that can be used to measure the relative effort to transport the software for use in another environment or to convert software for use in another operating environment, hardware configuration, or software system environment. [IEEE TUTOR] (4) The ease with which a system, component, data, or user can be transferred from one hardware or software environment to another. [TAFIM]

- *Scaleability* - (1) The ability to use the same application software on many different classes of hardware/software platforms from personal computers to super computers (extends the portability concept). (USAICII) The capability to grow to accommodate increased loads. {TAFIM}

In reality, systems are not purely open or closed. Because industry standards do not generally meet all military needs, trade-offs must be made between performance, cost, supportability, availability of standards based products, and the ability to upgrade. The result is that for any given system, the degree of openness may have many interpretations.

2.2 Standards and Standards Bodies

Open system interface standards are the infrastructure of open systems design, the building blocks of an OSE. They support the OSE as they codify open system ideals. Standards are essential if the desirable features of open systems are to be achieved. Standards help provide consistency and compatibility within, across, and between OEM products. An open system interface standard is an agreed-upon specification, identifying services and protocols, and where appropriate, mechanical form factors.

The Institute of Electrical and Electronics Engineers (IEEE) defines a standard as “A document, established by consensus and approved by an accredited standards development organization, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order and consistency in a given context.”, (IEEE 1003.0 Draft 16, page 19). Accreditation is a function of the international organization for standards (ISO).

In the choice of standards for consideration, the objective is to select standards at as high a level in the standards hierarchy as possible. National and international standards are developed in open forums where users and providers reach consensus concerning specifications. Consortia standards are usually developed by a group of product manufacturers on a majority rule basis. The order of precedence for selecting interface standards is shown in table 2-2.

STANDARDIZATION LEVEL	STANDARDS BODIES
International	International Telegraph and Telephone Consultative Committee (CCITT) International Organization for Standards (ISO)
US National	American National Standards Institute (ANSI) American Society for Testing and Materials (ASTM) Institute of Electrical and Electronics Engineers (IEEE)
Consortia	Open Software Foundation Structured query language (SQL) Access X/Open Asynchronous Transfer Mode (ATM) Forum

Table 2-2 Order of Precedence for Standard Selection

Other types of standards include Federal Information Processing Standards (FIPS) published by the National Institute of Standards and Technology (NIST), various government standards, military standards, and *de facto* standards. *De facto* standards may be proprietary or open but are not recognized by a standards body.

However, due to widespread use, *de facto* standards have become accepted in industry as a *standard*. Examples of *de facto* standards are: Microsoft MS-DOS, IBM Systems Application Architecture (SAA), and Adobe Postscript.

2.2.1 Standards Features and Profiles

Each standard consists of mandatory, optional, and conditional features that are typically put together in functional groups referred to as a standard's profile. The commercial market place usually aligns itself with a standards profile (rarely more than one) in a given product market. Product implementations reflect the industry aligned profile of interface features.[1] A system is comprised of various standard(s) and associated profiles integrated to form a set of functions that achieve system requirements.

In order for the interfaces to function efficiently, the optional features of each of the interfaces must be aligned (the same or at least have a common subset). This creates the need to document the features implemented for each of the interfaces in a standard(s) profile. The interfaces used by a system regardless of where that system falls in the hierarchy (figure 2-1) need to be profiled to fully define the data structures, protocols and physical characteristics.

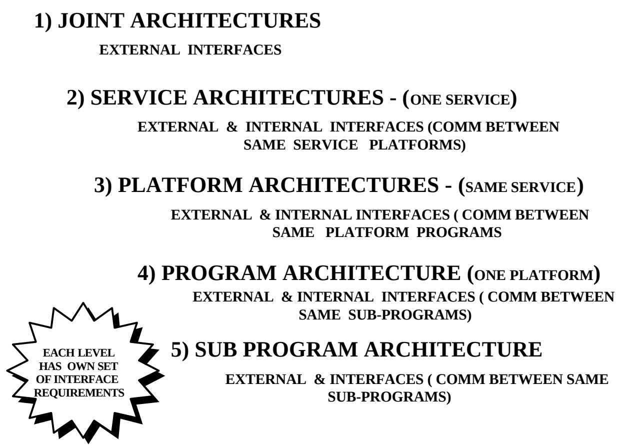

Figure 2-1 Interfaces to External and Internal Requirements

Figure 2-1 illustrates how interface requirements relate to each other depending on where the system is in the system-of-systems hierarchy. At the Joint level, external interfaces between Service systems and products need to be identified and assessed to ensure Joint Interoperability requirements are addressed and satisfied.

At the individual Service level (e.g., US Navy), external and internal (Service unique) interface requirements are defined (profiled) to achieve interoperability.

As the requirements are defined for individual platforms, considerations of interfaces can again be seen at the external and internal levels. The external interfaces address system architecture requirements from platform to platform; internal interfaces address system to system (and equipment) interface requirements.

At the equipment level, the interfaces can again be considered as external and internal. This process and interface consideration continues downward until there's no interface to define and profile, at the configuration item.

[1] Refer to Internet http://xystar.crane.navy.mil for more information on standards and profiles.

Profiling of interface standards is critical to the whole process. In this instance profiling means not only the listing of interface standards but further delineation of how these standards are applied to the design of the system or product being acquired to meet the requirements. It's one thing to identify what standard is needed to obtain interoperability but it's more difficult to come to agreement what part of the standard needs to be implemented to get to interoperability in the most cost effective manner to all.

The need for documented commonality of interfaces is rooted in the concept of Joint operations. The concepts of "Joint interfaces"[2] and "system-of-systems" refer to the interfaces common between systems in different Services (i.e., Army, Air Force, Navy, and Marines) and a system made up of stand alone sub-systems respectively. This requirement generates the need for common data definitions, data formats and symbology, as well as to transmit, receive and present this data across Services, platforms, and other organizational lines. One way of visualizing the interfaces involved in these concepts is that Joint interfaces communicate between the Services, Service unique interfaces communicate between the same Service's platforms, and system interfaces communicate between the sub-system(s) as shown in figure 2-2. The interfaces required at the Joint level only need be present on the Service interface(s) to the Joint interface. There are many standard interfaces that make up the full list of Joint interfaces. Likewise the interfaces required at the Service level only need be present on the system interface(s) to the Service interface. Thus the interfaces required for Joint interoperability among the Services are not necessarily universally common across all Service platforms and systems.

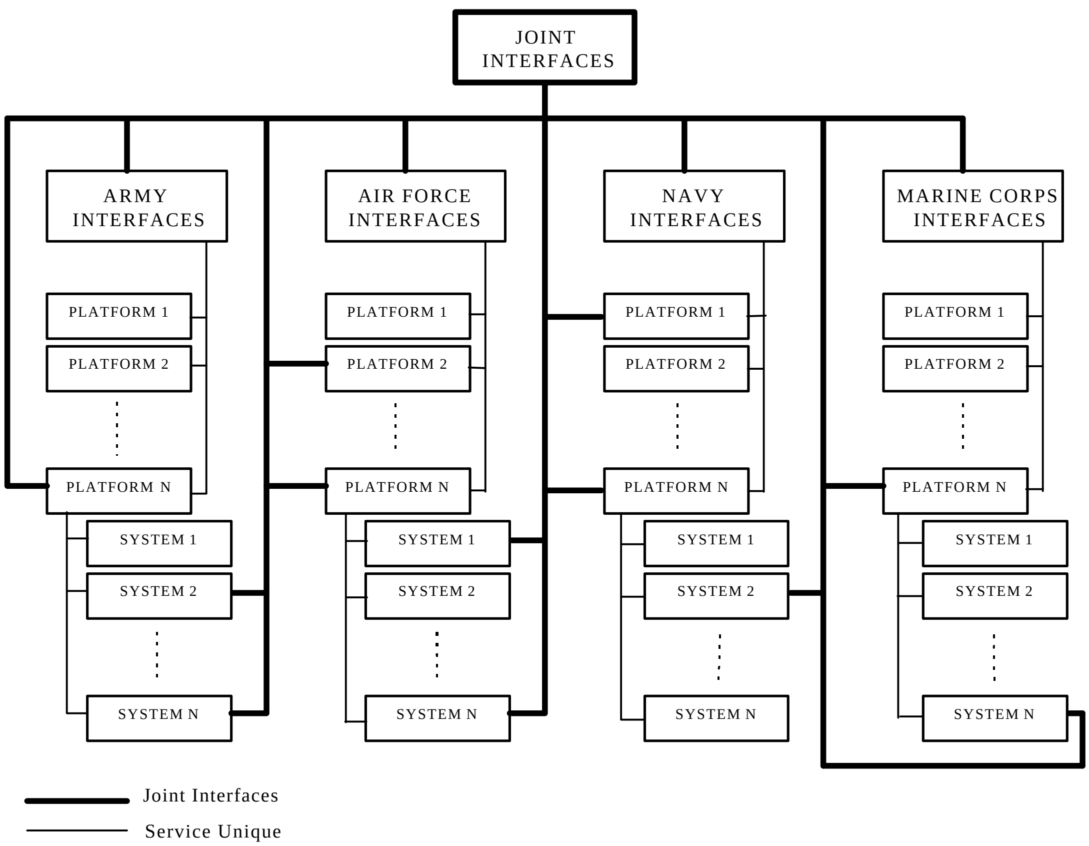

Figure 2-2 Interface Relationships

2.3. Advantages and Considerations

In the past, DoD suppliers (major contractors) built the majority of the parts they supplied in DoD systems. Now, they buy open interface standards products from a range of other suppliers, including competitors,

[2] Refer to paragraph 2.5.2 for more information on Joint architectures.

integrating them into larger scale assemblies (cards, boxes, systems) for sale to the government just as to industry. Interface commonality and stability makes this integration possible. The change to open systems means DoD is becoming a participant in the worldwide market for standards based products.

In an open system environment, time and cost for system design, development, and integration can be reduced through the use of non-developmental items (NDI) and commercial items. Other advantages include: increased system flexibility; lower acquisition costs; rapid prototyping and fielding; and if properly planned and managed, lower life cycle costs due to the ability to leverage a competitive commercial market. Additionally, system upgrades can be made incrementally and without the need for a major system redesign.

2.3.1 The Competitive Market

Open systems provide many advantages to users, system managers, and OEMs. DoD now has the potential to mix and match competitive commercial item products from many commercial sources that may be available in an open system environment; thereby, creating an OEM-neutral environment. From an acquisition view point, more product sources implies competition, resulting in decreased prices and increased performance and OEM support services. Competition also offers the possibility of a best-value choice for a given system acquisition. An OSE permits support costs to be leveraged from the commercial marketplace. This is accomplished by using commercially based support products and services, supplemented only as necessary. Typical commercial support includes: technical consultation; technical documentation; upgrade and repair of hardware; software maintenance; and training.

The benefits of open systems are not limited to large OEMs capable of taking advantage of economies of scale. Any OEM can build systems from lowest replaceable units (LRU) marketed by any other OEM. Thereby, OEMs are more competitive, yet cooperative, among themselves, encouraging higher quality products and services. Unlike proprietary system acquisition, users no longer must rely solely on the OEM for sources of compatible products for system support, expansion, upgrades or replacement parts.

Open system interfaces allow applications (software) to be decoupled from supporting hardware. Applications can then be developed separately and more easily migrated among differing hardware. Additionally, hardware changes do not necessarily force costly code changes in applications because use of standards achieves commonality at the interface level.

2.3.2 Benefits and Challenges

The above described benefits are not without challenges. Challenges arise from the use of standards themselves. Ambiguities exist within many standards, resulting in contractors offering incompatible implementations of the same interface standards. Sparing commercial items may be unsuitable for some military environments. Long term spares support of commercial items is subject to the vagaries of the commercial marketplace, where here-today-gone-tomorrow is a common state of affairs.

Some of the acquisition benefits and challenges attributable to an open systems environment are listed in table 2-3. The point to be realized from table 2-3 is that the availability of products and existing services far out weighs the negative aspects of overcoming any of the challenges (challenges may not be disadvantages).

BENEFITS	CHALLENGES
• Availability of current technology products for initial design/productions, support, and upgrade. • Low unit cost for products.	• Keep modernizing our systems or our adversaries will have more capability than us. • Our adversaries, real and potential, have access to

BENEFITS	CHALLENGES

• Ability to leverage commercial support, not invest to create and maintain it ourselves.
• Support through upgrade yields better and better performance over years of system use.
• More knowledge of products and their total costs (includes support) prior to committing to their use.
• Existing products that can:
  • Reduce procurement lead time.
  • Provide existing support structure(s).
  • Provide planned product improvements by the OEM.
  • Have an established upgrade path.
  • Have known (or derivable) costs.
	the same technologies we do.
	• Need to structure contracts to match marketplace changes with respect to product availability and price changes.
	• Reduce contracting lead time.
	• Keep up with what is going on in commercial markets, e.g., ongoing market survey, test, and evaluation.
	• Handling higher configuration management workload.
	• Manage changing technologies' affect on maintenance costs.
	• Accept that standardization process is slow compared to the evolution of technology (state of the art)

Table 2-3 Open System Acquisition Benefits and Challenges

2.3.3 Influences on Supportability

An OSE influences how we provide for supportability. Despite the many considerations for supportability due to an OSE, there are also many potential benefits. Table 2-4 depicts several supportability benefits and considerations.

BENEFITS	DISCIPLINES	CONSIDERATIONS
Lower support acquisition cost. Leverage the commercial investment. Earlier availability.	General Supportability	Rapid incremental upgrade. Lack of Navy control. ILS products not to Navy formats.
Earlier Planning data. Existing support systems. Upgrade in lieu of repair.	Maintenance Planning	Schedule compression. Repair turn-around time. Upgrade in lieu of repair.
Potential for fewer Navy Enlisted Classification (NEC) types. Potential for fewer personnel.	Manpower and Personnel	
Just in time approach. Increased initial competition. Potential increased commonality.	Supply Support	Changing products. Product configuration stability.
Standard interface analyzers. Commonality.	Support Equipment	Normal NDI issues
Lower cost. Early availability.	Technical Data	No control (changes, format, media). Data rights ownership. Licenses and royalty agreements.
Commercial training. Potential for less intensive training.	Training and Training Support	Course content control. Potential for more frequent training.
Earlier "ilities" data available. Facilitates proactive support team Ease of upgrade.	Design Interface	Changing product families. Design is not build-to print.
Interchangeability matrix concept.	Configuration Management	No Navy control. Rapid NDI product turnover. Other normal NDI issues.

Table 2-4 Common Supportability Benefits and Considerations in Using Open System Interface Standard Products Not Developed Specifically for the Government

If the government initially procures an NDI/commercial item product and does not pay for its design, getting necessary documentation of any unique design features (to enable reproduction or emulation) may be costly

or impossible. Even if an initial design was paid for by the government, reproduction of design features still may be difficult. Documentation and manufacturing process differences among design/production houses drive this issue.

The commercial marketplace maintains configuration control, technical data control and support control of the products. Even if the OEM and his competitors are fully engaged in the given market segment and the system has no unique interface features, the government or system integrator does not have the ability to control the support environment as it used to do.

The market place will continue to upgrade product lines while abandoning specific obsolete products as driven by market forces, both military and commercial. Commercial support must be continuously monitored. Contingency plans must be developed to handle discontinued commercial product support.

2.3.4 The Challenges of Non-Conformance

The magnitude of the challenges increase when products being procured (NDI/commercial item or developmental) do not fully conform to interface standards and profiles. Acceptance of proposed extensions to or deviations from standards to achieve desirable performance advantages often leads to sole source relationships for the entire life cycle that negates or severely reduces the advantages of open systems designs. A trade-off study should be made to determine the real necessity of accepting the extensions in terms of performance, cost-effectiveness, and supportability factors.

The more a product differs from standards and profiles, the more a customer is dependent upon the OEM for upgrades. In this case, the uniqueness of an initially-chosen product or design solution becomes a disadvantage. An OEM may be more expensive than anticipated, go out of business, or abandon a particular product line or market segment.

2.4 Transitioning to an Open Systems Environment

Understanding open system interface standards allows the evaluation of technical, cost, and availability information in order to make better decisions and more accurate cost projections between the architectural alternatives. Consequently, the challenge is to assemble an effective integrated product team (IPT), determine alternatives, examine and make comparisons, and contract for the most cost-effective alternative. The use of open system interface standards does not eliminate the need for meeting programmatic requirements and applicable laws. However, the use of open system interface standards can accelerate the actual availability of products and reduce their inherent costs.

2.4.1 Availability of Information

Information needed to take full advantage of open systems falls into several areas. First, the entire acquisition team needs an overall understanding of open systems. The second is knowledge of the individual standards and profiles being considered. Third, the entire acquisition team must operate from a common framework. Information about individual products to be developed or bought must be acquired and analyzed. The acquisition planning IPT should know the following about a product:

- Was it produced specifically for commercial or government markets?
- Is it accepted in those markets?
- Have upgrade pathways been developed?
- Is product support available?
- What is the quality of the product?
- Does the product conform to the standards as claimed and does data exist to provide verification?

Individual standards and technologies information is available from various sources. A number of trade associations, standards bodies and training firms have developed tutorials on specific standards. Detailed product information can be obtained from various sources. Industry sources include databases maintained by trade associations, data available directly from OEMs who advertise in trade publications and trade publications themselves. Related DoD Internet links include: http://www.itsi.disa.mil and http://www.acq.osd.mil/osjtf

Other information can be obtained through market surveys. Market surveys provide acquisition and supportability information for NDI/commercial item products. Market surveys can also be used to evaluate commercial OEM interest in developing new open system interface standards based products to meet unique system requirements, e.g., MIL-STD-1397 type B (NTDS FAST) interface. Even in a purely developmental situation, the interface standard (and probable silicon chip sets) already exists and is ready for use.

The importance of conducting market surveys and trade-off studies prior to finalizing a performance specification cannot be overemphasized. How to apply market surveys to an acquisition is discussed throughout section 3 with more data on market surveys discussed in section 5.1. Schedule and cost comparisons made possible by market surveys should drive the selection of standards, standard profiles, and products. This task, when well done, can be expected to provide the basis for much more accurate and defensible planning, programming, and budgeting system (PPBS) forecasts than was the case in traditional stovepipe acquisitions.

2.4.2 Initial Planning

Planning early in the acquisition life cycle can turn risks into opportunities. In an open system environment this involves:

- comparison of system performance requirements to the inherent capabilities of candidate open system interface standard(s),
- determining the relative acceptance of the candidate standard(s) in commercial markets,
- analyzing and comparing alternative products that implement the candidate standard(s) for suitability in meeting performance requirements,
- anticipating yearly costs for each alternative,
- predicting initial and long-term supportability requirements and upgradeability, and
- ensuring no deviation from open standards.

If the government initially purchases a commercial item, then the size and condition of that product’s market becomes a driving force in finding and selecting competitive products for upgrades and support. If the market for the initial product is large, several manufacturers and distributors of the product can be drawn upon. Just as an initial purchase leverages the commercial marketplace, bringing its cost down, the same investment can be leveraged during support implementation and upgrading. If underlying open system interface standards become obsolete, then the military will need to upgrade accordingly unless special arrangements are made (for example, life-of-type sparing).

To take full advantage of open systems benefits, the following points should be considered when planning system acquisitions, upgrades, and support.

PLANNING CONSIDERATIONS
✓ Technologies, standards, profiles, and products change with time and market conditions.
✓ Eliminate proprietary interfaces unless necessary for performance considerations.
✓ The product baseline to be maintained and upgraded must be based on standards, profiles, and products which implement them.
✓ A market survey is a critical first step in defining what can be accomplished, the costs, and when. This includes long term support and upgrade planning, life cycle cost forecasts, and comparisons.
✓ Usage of open products to provide opportunities to compete upgrades and support.

PLANNING CONSIDERATIONS
✓ Market surveys must be kept up-to-date to enable support and upgrade. Product choices must be based on standards, profiles, and supportability, not just unique performance attributes.
✓ Conformance of products to selected standards and profiles is critical. Conformance testing provides the foundation for successful system integration, future upgrades, and support.
✓ Test and evaluation of products and product upgrades continues throughout the system life cycle and must be funded.

2.4.3 Unique Interfaces

A clear upgrade path may not be possible if unique interfaces are used. To enable smooth upgrades and product support after an initial item is no longer available, the government can expect to pay for designing, integrating, and testing upgraded products. Thus, unique interfaces mean cost and schedule risks that must be examined in the early phases of acquisition planning.

Proposed deviations from commercially-accepted open system interface standards need to be evaluated for the relative need and life cycle impact. This evaluation should be made during the planning and implementation of initial specifications. One method encompasses developing a list of interface features to be implemented by a prospective developer and identifying the corresponding performance requirements. The program office must determine if the developer is proposing to sell unneeded uniqueness or if the government requirements are driving the uniqueness. If the government requirements are driving the uniqueness, then the program office should re-evaluate requirements and priorities. A second scenario might be when a proposed design calls for the use of a product but the contractor claims the necessity of adding features to a product (i.e., adding a daughter-board to an accepted LRU). How this product change affects the LRU needs to be carefully evaluated and tested prior to acceptance.

2.4.4 Risk Management

Risks, and the management thereof, are not fundamentally different for an OSE; however, some additional attention needs to be given to the following potential risk areas:

- Maturity of the standard.
  - Consensus based controlling body (avoid proprietary standards).
  - Adequacy for military use.
  - Commercial acceptance.
- Interoperability of products via the same stipulated interface.
- Product conformance to interface standard requirements.
  - Use of proprietary extensions to interface standards.
- Product interface applications modified by the OEM without notification.
- Discontinuing product lines without warning.
- Changing key features within a product line without notification.
- Changing parts on an LRU without notification.
- Delivery schedule variances.

The risk areas must be mitigated in order for the program office to gain the advantages of open systems. Some considerations to reduce risk management are captured in the following table.

RISK MANAGEMENT CONSIDERATIONS
✓ Are risk management, mitigation, and abatement efforts addressed by the program office? • Are risk abatement modeling and simulation tools available? • Has the staff been trained to employ modeling and simulation tools? • Is there a requirement for proof of performance through modeling and simulation prior to down-selection of product? • Is a risk management plan defined and roles assigned? ✓ Are incentives in place within RFP/contract for risk abatement by the contractor? ✓ Does sufficient test data exist to ensure conformance to specified standards and requirements? ✓ Are the selected standards and profiles changing rapidly? (Some change must be ongoing or the standard is obsolete.) ✓ Has a program schedule been developed and adhered to? • Is the schedule being tracked? • Have critical paths been identified? • Are critical paths tracked? • Is the schedule achievable within program resources? ✓ Are vendor/subcontracting schedules part of the planning/scheduling effort? ✓ Are key cost drivers identified and being tracked? ✓ Has an ample market survey and conformance test effort been conducted on NDI/commercial item products prior to down-selection and integration? ✓ Have prototyping and early operational testing efforts been performed before finalizing an evolutionary acquisition program? ✓ Have cost-effectiveness studies been performed and issues addressed prior to prototyping?

2.4.5 Quality Assurance (QA)/Management(QM)

A QA/QM program should be established which provides a methodology oriented toward prevention, detection, and correction of defects. If the contractor has an acceptable existing QA capability, such as the ISO 9000, the program should incorporate it. In an OSE, as in any acquisition, QA should be planned as part of the QM process and implemented in the very beginning. Regardless of the selected QA system, the program office needs insight into the contractor QA efforts so that contractual compliance is monitored. In the past, QA was achieved by constant testing of a product throughout the product's development and out year life cycle. Today's QA environment strives to establish a process (e.g., statistical process control) for monitoring and controlling critical processes. The QA system should: have a mechanism for feedback of field product performance; implement an effective root cause analysis and corrective action system; and, include a continuous process improvement program. Key questions to ask are provided as follows.

QUALITY ASSURANCE CONSIDERATIONS
✓ Has the integrator and associated vendors/suppliers/subcontractor(s) demonstrated adherence to a well accepted QA evaluation process (e.g. SEI, ISO 9000 series, Baldridge Award, certification, etc.)? ✓ Are requirements stipulated in the SOW that require QA certification or compliance standards for those participating in the integration/development/production of the system/equipment? ✓ Has conformance testing been conducted on parts/components/LRUs that are in use commercially and which fulfill functional requirement and open system interface standards applications? ✓ Is environmental stress screening part of the integrator and vendor/supplier's acceptance process?

2.4.6 Software Engineering

Both benefits and risks result from the transition to an OSE, especially when commercial software products are incorporated which were not developed for the program. One benefit is that functional and performance requirements may be satisfied with commercial software. This spreads costs over a larger marketplace, reducing life cycle costs (LCC) to DoD users. Each program office should track commercial products it uses to ensure that the version of software integrated into the design is not modified without the government's knowledge. However, the capability to track version changes is dependent on configuration management policies and procedures.

The contract specification and SOW need to stipulate performance requirements for the following:

- Software adaptability.
- Portability.
- Scaleability.
- Documentation of extensions to standards/profiles.
- Test documentation (test procedures and resultant and test data) to facilitate reuse.
- Functionality.
- Use of standard data definitions.
- Avoidance of proprietary products.

The contract's specification must state how these attributes will be verified (inspected, analyzed, demonstrated or tested). These same requirements apply to software developed specifically for the program/system. Again, a crucial element is deciding which specific application program interfaces will be used, i.e., what subset commercially based standards/profiles will form the interface baseline.

2.5 DoD Initiatives and Requirements

Open systems usage is part of a larger transition, the move from basing defense systems on DoD unique interfaces and products to normative use of commercial standards and products, modified only as necessary to meet defense needs. It is not the intent of this Guide to address all the nuances and ramifications of this change but to focuses on the effects of open standards usage (and the open systems environment thus created) on Navy acquisition programs, procedures, and costs. Other aspects of the change to open systems are addressed throughout the document.

2.5.1 Business Centered Approach

The DoD business centered approach is a shift of strategy and tactics toward meeting DoD materiel needs. Administrative and policy aspects of the business centered approach include cost as an independent variable (CAIV) and the mandatory use of commercially based open system standards as the architectural basis for system development and upgrade. CAIV is the methodology to acquire and operate affordable systems by setting aggressive, achievable cost objectives and managing achievement of these objectives. In terms of an OSE acquisition, the program office needs to establish cost objectives to balance mission need with projected out-year resources while taking into account anticipated process improvements in both DOD and the commercial marketplace. In place of the traditional "define the requirement and see what it will cost to meet it" approach, we now treat cost as a key driver in the choice of what will be developed or purchased. Unless there is strong reason to do otherwise, capabilities are procured to the extent that available funding allows, not necessarily to fully meet a defined requirement. Requirements will be re-negotiated in light of availability of funds. Expensive programs, from large systems to small upgrades, may be canceled. Within this constraint, a best value approach is to be used.

The business centered approach places DoD acquisition programs in a new and different position relative to industry. In the past, DoD was a driving force and sometimes the only driving force in development of high technology products. The enormous expansion of world wide commercial markets and contraction of DoD budgets has made industry the largest investor in high technology, developing leading edge products to meet commercial market needs. This change has vastly increased the availability of a wide range of high technology products which

can meet many military system requirements. In fact, there are often choices to be made between competing technologies and products, each of which may partially or fully meet DoD system use requirements.

How high should the technology be? We do not always need leading edge “state-of-the-art” technologies and products to meet defense needs. Purchase of leading edge “state-of-the-art” available for “laboratory use only” products is often not cost effective. There are real advantages, to use of “state-of-the-practice” products, particularly for fielded systems.

State-of-the-art products often use unique interfaces, which may and often do change prior to release of production run quantities of products for commercial market applications. Products which conform to open interface standards generally have well thought out, well understood, and well documented interfaces. The stability of state-of-the-practice product interfaces results from the consensus process used to develop and test them prior to release as approved commercial standards and use by industry.

State-of-the-practice items generally interface via open interface standards. The performance of these interfaces is a known factor. Open systems interface standards are readily available to designers who in turn use the standards to speed design and achieve predictable performance levels. Because other designers are using the same interfaces, integration of competing or complementary products is easier. The achieved level of commonality and maturity reduces the risks (time and cost) associated with product integration, making system design, support, and upgrade easier to accomplish.

Table 2-5 compares the business aspects of these alternatives.

State-of-the-Art Implies	State-of-the-Practice Implies
Instability of interface design, rapidly evolving design changes	Stable interface design
Use of proprietary interface(s) to capture market share	Standardized interfaces
Questionable performance parameters	Known performance
Difficulty in integration/interoperability	Integration easier because parameters and interface behaviors are known, stable, and documented
Lack of producibility, low production rate	Item is in production
Questionable reliability	Reliability has to meet commercial expectations, be high enough to meet cost, warrantee, and reputation requirements
Lack of technical support for developers and integrators	Technical support in place to support expansion of product market
Lack of spare parts and repair support	Spares and repair available - routine items.
Lack of technical data to enable training and repair	Technical data developed, routinely available
Inability to order large quantities	Production is underway, needs can be accommodated
High per unit cost	Lower per unit cost, decreasing
Delays in getting the product	Product routinely available

Table 2-5 State-of-the-Art vs. State-of-the-Practice

2.5.2 Joint Technical Architecture Overview

With the growing emphasis on Joint operations, numerous efforts at the DoD level are underway to evolve legacy systems to an overarching architecture that promotes Joint interoperability and acquisition efficiency. Implementation and deployment of supporting systems will be realized through the use of a technical infrastructure comprising common workstations, core capabilities (applications) across functional domains, and common data elements (i.e., data structures). This commonality will be predicated upon the use of DoD consensus interface

standards and specifications, and the availability of commercial item and government off-the-shelf (GOTS) software and hardware products that adhere to selected common standards and specifications.

2.5.2.1 Architecture Background

In the early ‘90s, the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (ASD (C3I)) recognized the shortfalls in the acquisition of systems and deployed systems capabilities. The ASD (C3I) directed the Defense Information Systems Agency (DISA) Center For Standards (CFS) to perform the role of executive agent for all DoD information technology (IT) standards initiatives. The primary objective for the CFS has been to identify a single framework to promote the integration of DoD information systems. This effort resulted in the development of the DoD Technical Architecture Framework for Information Management (TAFIM) which establishes the direction for an open systems environment (OSE) that focuses on a Standards-Based Architecture (SBA) critical to achieving interoperability and cross-functional integration. TAFIM provides a technical reference model (TRM) and standards selection guidance based on identified Service areas (i.e., functional areas) and DoD consensus standards from industry and DoD. By identifying Service areas, the TRM establishes a common denominator among DoD Commander-in-Chiefs (CINC)/Services/Agencies (C/S/A) in which to select and specify supporting consensus standards. Implementation of TAFIM, as mandated by DoD 5000.2-R, surfaced ambiguities with respect to the level of abstraction in which to apply the SBA process; and Joint interoperability given multiple and competing standards for an identified Service area. As a result, a widespread perception formed that architectures are stovepiped, piecemeal, and disjointed.

In October 1995, the C4ISR Integration Support Activity (CISA) established a DoD-wide C4ISR Integration Task Force (ITF) to develop coherent integrated C4ISR architectures framework. In June 1996, the C4ISR ITF produced the CISA-0000-10496, *C4ISR Architecture Framework Version 1.0* document which establishes a standard set of rules, products, and guidance for the development of C4ISR operational, system, and technical architectures.

In November 1995, the ASD (C4I) issued a memorandum to DoD C/S/As to establish a single, unifying DoD technical architecture that will become binding on all future DoD C4I acquisitions with the intent to broaden the scope to later address weapon systems and automated information systems (AIS) acquisitions. This effort resulted in the development of the DoD Joint Technical Architecture (JTA) that was subsequently mandated in August 1996 for DoD wide use by the Under Secretary of Defense for Acquisition and Technology (USD (A&T)). The purpose of the DoD JTA is:

- To provide the foundation for a seamless flow of information and interoperability among all tactical, strategic, and sustaining base systems that produce, use, or exchange information electronically.
- To mandate standards and guidelines for system development and acquisition which will significantly reduce cost, development time, and fielding time for improved systems, while minimizing the impact on program performance wherever possible.
- To influence the direction of the information industry's standards-based product development by stating the DoD's direction and investment so that information industry's development can be more readily leveraged in systems within DoD.
- To communicate DoD’s intent to use open systems products and implementations to industry.

2.5.2.2 Standards Selection Criteria

The standards selection criteria used in developing the JTA generally focused on mandating only those items critical to interoperability that were based primarily on commercial open system technology, were implementable, and had strong support in the commercial marketplace. The specific guidance given in selecting standards was that standards would only be mandated if they meet all of the following criteria:

- *Interoperability and/or business case.* They ensure Joint Service/Agency information exchange and support Joint (and potentially combined) C4I operations, and/or there is strong economic justifications that the absence of a mandated standard will result in duplicative and increased life-cycle costs.
- *Maturity.* They are technically mature and stable.
- *Implementability.* They are technically implementable.
- *Public.* They are publicly available (e.g., open system standards).
- *Consistent with authoritative sources.* They are consistent with law, regulation, policy, and guidance documents. (Note: Recommendations for changes to these authoritative sources should be made, where necessary.)

The order of preference used to select the standards is as follows.: Standards that are commercially supported in the marketplace with validated implementations available in multiple vendors' mainstream commercial products shall take precedence. Publicly held standards are generally preferred. International or national industry standards are preferred over military or other government standards.

The word "Standards" as referred to in the JTA is a generic term for the collection of documents cited herein. "Standards" as cited in the JTA may include commercial, federal, and military standards and specifications, and various other kinds of documents and publications.

The JTA replaces the standards guidance delineated in TAFIM for DoD C4I applicable system acquisitions and is recognized as a living document that will evolve with time as technology and the marketplace changes. Application and requirement specification of any other standards (outside of those identified in the JTA) are intended to be additive, complementary, and assumed to be specific and unique to an intraservice mission area requirement.

2.5.2.3 Architectures

It is important to understand DoD’s *big picture* and its strategy for achieving a Joint OSE. *DoD’s big picture* is to define, develop, and coordinate Joint target architectures (operational, system, and technical) that are commensurate with projected requirements and the DoD information infrastructure (DII). Each Service is a *cog* in the picture and needs to ensure that the systems and products acquired to fit into that picture are interoperable and meet the performance requirements necessary to fulfill the mission designated for the product

As DoD enters into a new century, the methods of supporting operational forces will be significantly different from the past. Lessons learned have driven changes to acquisition policies and the realization of the need to revisit our method of supporting the Warrior. Defining and providing guidance in how acquisition and supportability of resources to meet these architectures will be accomplished and defining the requirements that the program office must fulfill will be critical to success.

The DoD JTA development is predicated upon the architecture framework concepts and guidance depicted in CISA-0000-104-96[3], and specifies a set of performance-based commercial information processing, transfer, content, format and security standards. In 1995, ASD (C3I) also issued a task which established the C4ISR Integrated Product Team now called the Integration Task Force (ITF). The ITF assigned the Integrated Architectures Panel (IAP) the task of defining the architecture process and to address the architecture planning

[3] C4ISR Integrated Architecture Panel , C4ISR Architecture Framework, Version 1.0. (4 June 1996).

and engineering concerns. Part of the IAP effort was to define what constitutes an architecture. The IAP was in agreement with the IEEE STD 610.12 definition of architecture as being: *the structure of components, their relationships, and the principles and guidelines governing their design and evolution over time.* To further clarify the architecture process within the C4ISR arena, CISA-0000-104-96 and the IAP defined[4] three types of C4ISR architectures as:

- *Operational Architecture*. Descriptions of the tasks, operational elements, and information flows required to accomplish or support a warfighting functions.
- *System Architecture*. Descriptions, including graphics, of systems and interconnections providing for or supporting warfighting functions.
- *Technical Architecture*. A minimal set of rules governing the arrangement, interaction, and interdependence or the parts of elements whose purpose is to ensure that a conformant system satisfies a specified set of requirements.

The two references document, identify, and define the operational, system, and technical architectures (figure 2-3) as part of an overall architecture framework.

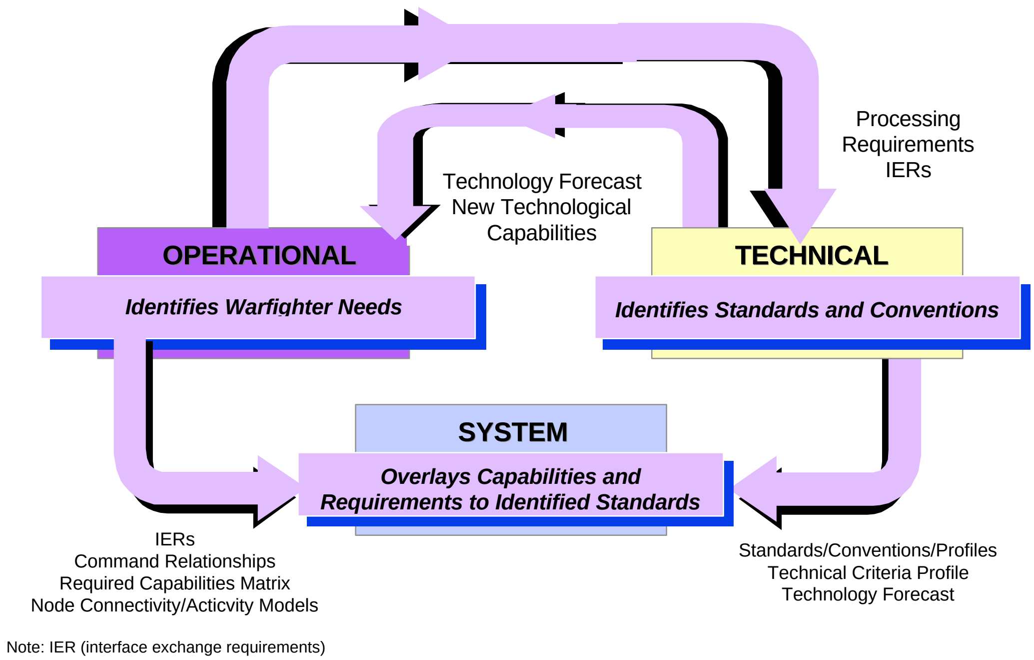

Figure 2-3 Operational - System - Technical Architecture Relationships

The C4ISR operational, system, and technical components are the base constructs assumed by numerous and ongoing DoD C4ISR architecture panels, committees, and working groups. In turn, these architectures serve to establish a set of:

- normalized activities independent of command structure,
- consensus standards among C/S/As with the objective of a single standard for a functional Service area,
- TRMs, and
- selected standards and associated standards profiles specific to each Service and warfare mission area.

[4] C4ISR Integration Task Force, Integrated Architectures Panel Final Report, September 1996.

The DoD OSE approach is intended to promote horizontal and vertical interoperability, use of open standards based systems, and faster acquisition cycle times. This approach encourages functional modularity that can be interchanged and upgraded with improved technologies as mission and budgets dictate

The ability to leverage commercial products to meet functional requirements within a DoD system became a realistic objective and has led DoD to expanding the evolutionary acquisition approach into including the use of NDI/commercial item products to satisfy architectural requirements. The essential engineering issue was to ensure the interfaces were adequately identified and profiled to ensure interoperability

The currently fielded architecture baseline(s) address the existing legacy systems, programs, and products. The emerging architectures reflect the effort to migrate from these legacy systems to an open system environment that provides for Joint interoperability without degradation to Service unique requirements. This means that the process to move to Joint interoperability must first achieve approval to go forward in the acquisition process by meeting Joint requirements. Program offices are supposed to be assessing their legacy system interfaces (including data protocol) for conformance with Joint requirements. As legacy interfaces are identified, they should be compared to commercially accepted open system interface standards to identify opportunities for possible migration to commercial products in meeting Joint interoperability requirements. As operational changes occur they are being assessed for how they impact both Joint and Service unique architectures.

These architectures are used to provide the user, engineering, and acquisition community the necessary perspectives to support systems acquisition for a given mission area and functional domain. This approach by DoD is intended to promote horizontal and vertical interoperability, open standards based systems; and faster cycle times through modularity of equipment's and subordinate functions that can be interchanged and upgraded with improved technologies as mission and budgets dictate. As shown, the development of each perspective (architecture) results in information (or products) that serves as the basis for the other two architecture developments and definitions. The approach is a continuum paced to leverage technology advancements for improved capabilities as well as promote interoperability, scaleability, and reusability.

2.5.3 TAFIM Acquisition Environment

Traditional DoD acquisition environments, based primarily upon proprietary products and isolated data processing systems have resulted in a costly, poorly integrated, and *closed* (rather than *open*) infrastructure in most organizations. The Navy recognizes the need to improve the use of existing technology while simultaneously developing new acquisition strategies to accommodate declining budgets, significant technological advances, and changing threats. Maintaining current and leading edge technology in *all* systems demands use of open systems to promote interoperability. The thrust of DoD acquisition mandates is to achieve an overarching investment balance for each DoD requirement.

The user, system engineering, and acquisition communities need a better means of coping with this changing environment and understanding the functions being supported to ensure warfighter needs are met with open systems. Today, the program office needs to assume a SBA planning approach if they are comply with the specific information infrastructure of DoD, Joint needs, and satisfy all architectural respective requirements. As a means to assist the program office, DoD has changed acquisition policies and issued a revision to the DoDI 5000.1 and DoD 5000.2-R. Included in the changes was the combining of the policies and regulations of the C4ISR, Combat Weapons Systems, and AIS under one policy. Part of this policy change is that C4ISR programs consider the Joint requirements in their acquisition. During the development of the mission need statement (MNS) and subsequently the operational requirements document (ORD), the Service and multi-Service requirements must be identified and stated.

For those programs that have multi-Service requirements, the MNS and ORD have to be approved by the authority shown in table 2-6. Concurrently, the Office Assistant Secretary Of Defense (OASD) has mandated the use of the TAFIM which comprises a set of guidance documents for developing an open system, including guidance on developing an SBA.

		Army	Navy	USMC	Air Force
Requirements Developer		TRADOC	OPNAV (N-8) Fleet CINCs	FMF/MCCDC	Operating Commands
Service HQ Lead Agency		DCS for Operations & Plans (DCSOPS)	OPNAV (N-8) (Program Sponsors)	DCS for Requirements & Programs	DCS for Plans & Operations (HQAF/XO)
Requirements Validation Authority	ACAT I/IA	ACAT I: Joint Requirements Oversight Council (JROC) ACAT IA: OSD Principal Staff Assistant (PSA)/JROC			
	ACAT II, III	Chief of Staff	Chief of Naval Operations	Commandant of Marine Corps	Chief of Staff
Requirements Documents		Mission Need Statement (MNS): Milestone 0 Operational Requirements Documents (ORD): Milestone I, II, & III			
Regulations		AR 71-9 AR 70-1	OPNAVINST 5000.42D SECNAVINST 5000.2A	MCO 3900.4D	AFPD 10-6 AFI 10-601

Re: Intermediate Systems Acquisition Course ACQ 201, ISAC Volume 1, Sept 96

Table 2-6 Multi-Service Approval Authority

The TAFIM comprises eight volumes of documentation that in sum, provides a TRM and standards selection guidance based on identified Service areas and DoD consensus standards (Volume 7) comprising industry and DoD standards. For applicable systems[5], the JTA replaces the standards guidance contained in the TAFIM (Volume 7)[6] By providing identified Service areas, the TRM (Volume 2) establishes a common denominator among DoD C/S/As in which to select and specify supporting consensus standards based on TAFIM defined work, application, technology, and information views. Additionally TAFIM provides a systems engineering SBA planning process that can be applied to any level of abstraction or enterprise in determining system requirements.

Provided in figure 2-4 is the seven step SBA process of TAFIM.[7] The process facilitates and promotes open system architectures and products to meet performance requirements. The SBA process offers a means to structure a common approach for the definition and development of a system with the intent to enable interoperability within and among DoD related organizations. Application of the SBA planning process provides a systematic approach to identify acquisition and implementation strategies with respect to requirements definition and standards selection. The SBA approach supports development and integration of individual systems and Joint Mission Areas (JMA).

[5] For a definition of applicable systems refer to paragraph 4.3.4 of DoD 5000.2-R.
[6] Refer to 22 Aug 96 memo, JTA Implementation, USD (A & T) and ASD (C3I).
[7] Refer to Internet: http://www.itsi.disa.mil/cfs.

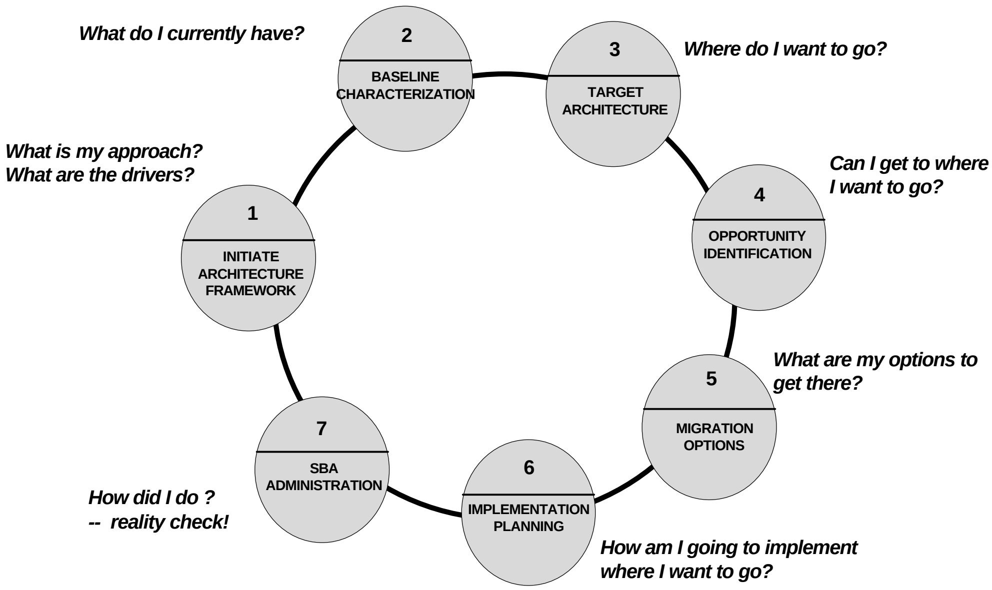

Figure 2-4 Seven Step SBA Process of TAFIM

The SBA provides a logical engineering processes to acquire system(s) in a timely, cost-effective manner, while reducing risk and ensuring supportability.

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3.0 ACQUISITION

This section provides a process for achieving a cost effective and best value open system acquisition approach which embodies current technology over an entire system's service life. Each of the process steps contained in this section are not fundamentally new; however, accomplishing the objectives of an open system environment (OSE) as described in section 2.0 affects their implementation.

Pursuant to the specification/standard and acquisition reform mandates, the focus of acquisitions is to specify system and equipment requirements in terms of:

- end item performance (vice *design processes*);
- hardware and software interfaces (interconnects and application program interfaces (APIs)) predicated upon consensus standards or open specifications; and
- Joint and Naval mission areas in the context of operational, system, and technical perspectives.

Figure 3.1 provides a high level engineering process for transitioning from a mission need through to a selection/decision process for open system acquisitions that correlate directly to the TAFIM's Standards-Based Architecture (SBA) concept.

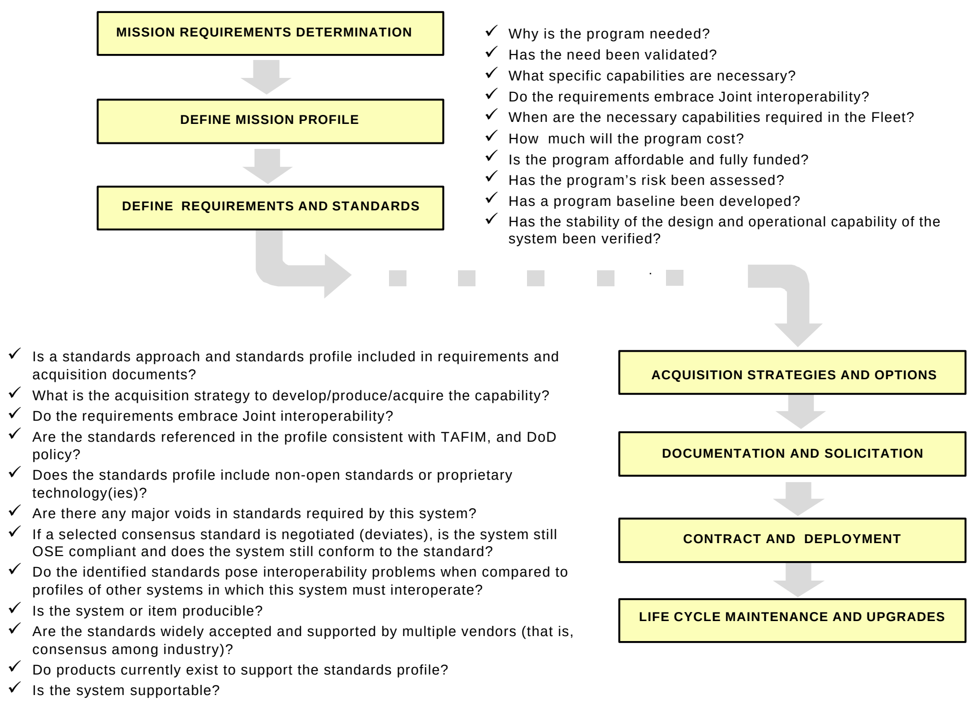

Figure 3-1 Acquisition Approach and Governing Considerations

Figure 3-1 correlates the process flow and subordinate processes addressed in the subsections of section 3. Each of these subsections address a segment of the open systems process and provides a set of considerations. It is important to remember that in an OSE acquisition the processes do not always have to be performed sequentially;

they can be performed concurrently or iteratively as appropriate. When risks or issues arise, actions may dictate a revisit to a particular process area to reaffirm or redefine an interface, perform a market survey to identify new or replacement product(s) or technology upgrades/replacement, and other related OSE acquisition considerations.

Using evolutionary acquisition and acquisition streamlining initiatives can enable the acquisition of new systems at a reasonable cost and in a manner that responds to requirements in a timely fashion (i.e., commensurate with technological advancements). Proposed systems are assessed for compatibility and interoperability with respect to emerging technologies, product availability, and application to legacy environments. Legacy environments are evaluated for Joint and unique Service adequacy and supportability, and the potential for migrating to an OSE. Figure 3-2 reflects an OSE acquisition process and identifies the corresponding figures in section 3 which portray the process described in each block.

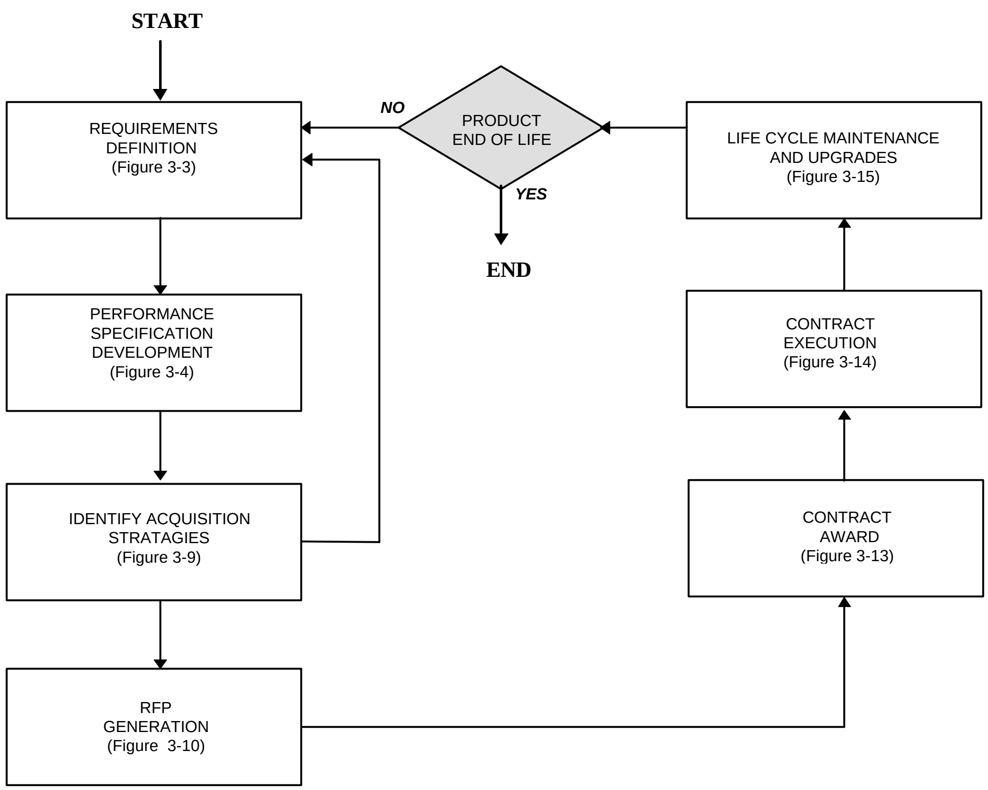

Figure 3-2 Iterative Acquisition Process

DoD[8] is using performance-based contracts to leverage commercial markets in an attempt to reduce acquisition and supportability costs. Acquisition efforts can range from major DoD system acquisitions using a full developmental approach to an evolutionary approach which employs maximum use of commercial item products in the design. This section summarizes the processes involved in acquiring and supporting DoD systems using OSE based acquisition concepts.

3.1 Requirements Definition

A program office changing from a legacy system to an OSE architecture should identify, assess, and document all hardware, software, and internal and external interface requirements. Interface requirements should reflect actual applications, protocols, etc. necessary for system performance. Each program office should consider

[8] DoDI 5000.1 and DoD 5000.2-R, 15 MAR 96.

establishing an integrated product teams (IPT) as early into the acquisition's life cycle as possible. The IPT should have DISA participation to help in the standard's selection process and thereby helping to expedite the Defense

Naval Warfare Mission Area and Required Operational Capability/Projected Operational Environment (ROC/POE)[9] defines the interactions between the Services at the Joint level. "Requirements for new or modified systems must be based on an approved need that addresses their use in Joint operations prior to requirement approval."[10] For Joint programs, acquisition and requirements documents require Joint level (i.e., J6) review and certification to ensure interoperability has been adequately addressed.

- Requirements documents require review and certification by J6 in which DISA (supporting Office Assistant Secretary Of Defense (OASD) C3I) is a key participant in the review and approval of the standards approach, standards profile(s), and conformity to selected standards.

The requirements definition process shown in figure 3-3 may be used to assess standards, profiles, and product applicability.

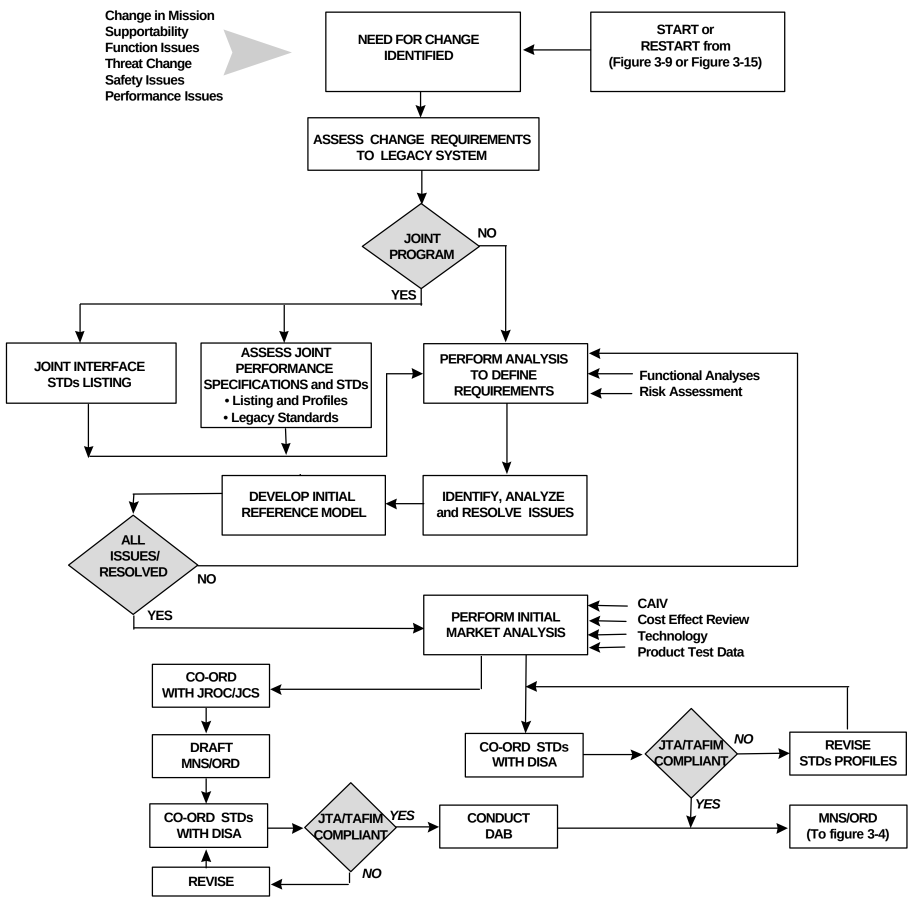

Figure 3-3 Process Flow: Requirements Definition

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[9] OPNAVINST C3501.2H, 2 NOV 87.
[10] CJSCI 6212.01A.

The result of the requirements definition process of figure 3-3 is the approval of the mission need statement (MNS), operational requirements document (ORD) which is used as the basis for developing other programmatic documentation. The initial reference model and functional block diagram are by-products of the MNS/ORD approval process. The following ORD and MNS considerations should be addressed.

MNS/ORD CONSIDERATIONS
✓ Is the MNS/ORD consistent with respect to Joint doctrine (e.g., Joint Publication 6-0 and 6-2)? ✓ Is the MNS/ORD consistent with current concepts for Joint or Multinational Forces Operations (e.g., Joint Pub 6-0 series)? ✓ Is the proposed system consistent with the DoD migration strategy? ✓ Does the MNS/ORD contain a statement indicating that the proposed system requires the following: • Compatibility with existing and planned C4I systems and equipment? • Interoperability with other DoD functionally related C4I systems and equipment? • Interoperability with Allied nations' functionally related C4I systems and equipment? ✓ Does the MNS/ORD describe, as applicable, key boundary conditions related to C3I interfaces and standardization or interoperability within the NATO or with other Allied or DoD components? ✓ Are any new strategic or nuclear operations interoperability issues raised by the new requirement? ✓ Does the MNS/ORD contain a standardization approach? ✓ Is the standardization approach consistent with the Technical Architecture Framework for Information Management (TAFIM) and DoD Information Technology Standards policy? ✓ If any standards are referenced in the MNS/ORD, are they consistent with the TAFIM and DoD Information Technology Standards policy? ✓ Was system security considered as a constraint that could adversely impact the resolution of any mission deficiencies? ✓ Does the initial reference model reflect the MNS/ORD? ✓ Does the functional block diagram reflect the MNS/ORD? ✓ Does the MNS/ORD express mission need to the extent that appropriate roles can be forecast for DoD strategic and tactical common user communications systems, command and control information systems, and National Military Command System (NMCS) command centers? ✓ Is the Joint Potential Designator identified? ✓ Are there present or programmed capabilities that could fulfill some or all of the requirements stated in the MNS/ORD? ✓ Are interoperability requirements consistent with validated architectures for the function being supported? ✓ Is there a need to modify existing architectures, or to develop new architectures to accommodate interoperability requirements?

3.2 Performance Specification Development

An OSE implies the use of multiple vendors of different functional products whose aggregate products are integrated by a prime contractor or system integrator. The need to adequately define a user's requirements is essential to an OSE acquisition. The performance specification is the primary vehicle to define program functional and performance requirements. A key part of the OSE process is the transition from an initial set of basic operational requirements to a well defined performance specification that defines the mandatory interface requirements necessary to achieve an OSE.

Figure 3-4 provides a high level view of the process of converting initial requirements into an OSE performance-based specification. As requirements are solidified, the data (i.e., derived requirements generated from the MNS, initial market survey information, and an initial selection of interface standards and associated profiles) are used to develop a draft system profile. This draft profile can then be used as the basis for development of a reference architecture model. If an ORD has not yet been developed and approved, this data can be used to solidify the ORD requirements and to develop a draft performance specification. The ORD should now be

sufficiently revised to describe how JTA and TAFIM requirements are being met. The draft system profile should identify a set of standards/profiles that address Service unique and Joint interface requirements. At this point, a more extensive market survey should be performed that considers system profile, reference model, performance specification(s), and especially life cycle supportability factors including related cost, schedule, and performance factors of end items under consideration for integration.

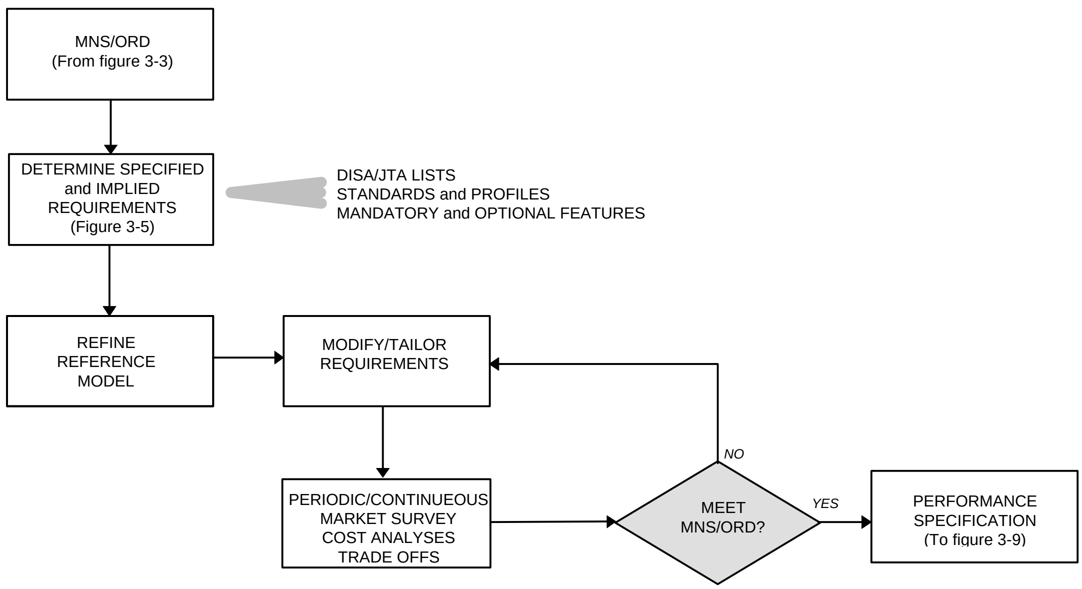

Figure 3-4 Process Flow: Performance Specification Development

The results of the market survey (section 5.2) are used to make programmatic and technical acquisition decisions, and in solidifying design and acquisition requirements. In order to refine and finalize the acquisition requirements, the market survey should:

- acquire sufficient data to fully specify the functional and performance needs of the acquisition,
- identify products that meet the standards and standard profile parameters and performance requirements,
- evaluate the degree to which products meet the requirements, and,
- determine if previous conformance and interoperability testing results are available.

Using the data from the market survey, perform a trade-off between candidate architectures (groups of interface standards) to determine if and what development effort is required and to identify the initial OSE acquisition baseline.

The survey data and final performance requirements for the OSE product should be integrated into acquisition documentation through a tiering process. Performance specification(s) and mission profile(s) may in fact require updating to reflect the market survey results. How well the derived set of requirements, standards profiles, market survey analysis, and generation of the OSE performance based specification are performed may directly correlate to the degree of risk, cost-effectiveness of the acquisition, and degree of achieving an OSE within the acquisition.

The derived set of requirements can be viewed as a tiering of standards and standard profiles as shown in figure 3-5. As lower level requirements are derived, more definitive information is needed.

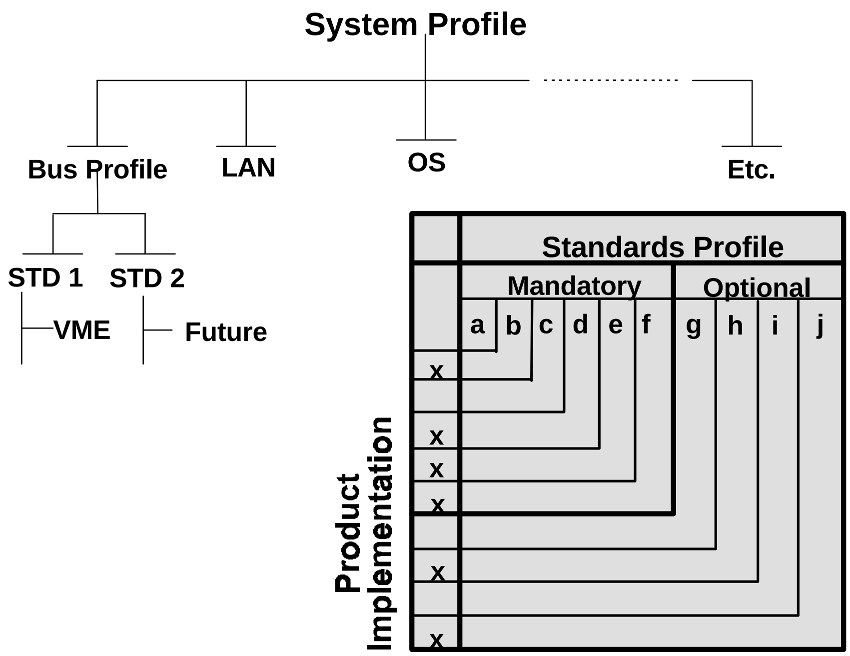

Figure 3-5 Tiering of Requirements

A tiering process is usually performed in two steps. First, the derived set of requirements are cross-linked to a set of open systems interface standards which, as an aggregate listing of standards, form the framework for implementation of the ORD requirements. Second, each identified standard currently employed within a legacy system is assessed and a determination made regarding which of the mandatory and optional requirements (section 2.2.1) from each standard is necessary for interoperability. The tiering process results in the initial baseline which includes the standards listing and associated standards profiles. The interface baseline and associated cost analysis data can be used to refine the performance requirements in the higher level documentation (ORD, etc.).

As part of the market survey, perform an assessment of candidate architectures and how well their associated products fulfill an identified function or set of functions. Then assign a set of cost and technical parameters to the candidate architectures so that when data for these parameters is accumulated, a matrix can be developed and a value and/or risk factor can be assigned to each parameter as shown in figure 3-6. Entries in figure 3-6 provide the IPT with the types of capabilities and risks (confidence factors) associated with the acquisition. Figure 3-6 is an example format for a summary comparison matrix. The matrix must be tailored for each individual program's unique requirements. For example, if products are being evaluated against the initial standards and standard profiles, then an assessment can be made of how well the products match the requirements. Test results can be reviewed to determine the product's capacity to conform and interoperate within program needs. If there is no product match to standards and standard profiles, then some combination of existing NDI/commercial item or an unique product development is required.

Program Plan	Candidate Architecture 1		Candidate Architecture 2		Candidate Architecture n	
	Value	Risk	Value	Risk	Value	Risk
Performance (e.g., range, MTBF, shock, etc.)						
Production readiness						
Supportability (e.g., maintenance cost per flying hour, provisioning costs)						
Schedule (e.g. initial operating capability, and full operational capability)						
Budget						
Life Cycle Cost (LCC)						

Figure 3-6 Summary Comparison Matrix

In addition, sufficient data should now be available to the IPT to consider/identify options (Implementation and Migration). The profiles necessary for decisions (functional, environmental, and supportability profiles) should be fairly sound with only some review necessary depending on the final selection of an acquisition strategy. For instance, the outcome of the market survey may require the supportability profile to be revisited prior to any decision to field the system/product by the integration of Non-Development Item (NDI) and commercial item products.

3.2.1 Life-Cycle Cost Comparisons of Candidate Architectures

Traditionally, life-cycle support of a system was planned during engineering and manufacturing development (E&MD) or production. By the beginning of E&MD, 85 percent of life cycle support costs had been determined by the system definition. In order to mitigate this cost risk, supportability trade-off studies need to be performed prior to the selection of standards and products. A life cycle cost forecast (i.e., costs for development, facilities, and out-year tasking to the ISEA/CFA, SSA, T&E, and other program support entities) should be developed for each candidate architecture. These costs are driven by the rate of change of NDI/commercial item products.

Even in a nominally pure developmental situation, using open system interface standards as the basis for system design promotes the use of NDI/commercial items, though at a lower design level. Interface related hardware products include chip sets, connectors, fiber optic cable, etc. Interface related software products include operating systems, development environments, programming languages, compilers, debugging tools, etc. Each of these products has existing supportability parameters, ranging from repair to technical consultation, upgrades, and licenses. These parameters must be analyzed and translated into probable program planning, including schedule, and cost. Life cycle cost and scheduling for each candidate architecture should be factored into the IPT's decision as to which architecture provides the best cost/performance tradeoff value[11].

Most open system interface standards based situations will involve mixtures of developmental and non-developmental products. To take advantage of available open system and product information, business management and supportability personnel must be involved in the IPT process during the early phases of the program and the market survey process. The challenge is to integrate developmental and NDI support elements, not only at the product level but also at the system level. Associated with this is a schedule challenge.

[11] DoD 5000.2-R, 15 MAR 96, section 3.3.3.

Supportability products (e.g., technical manuals, technical support services) must be planned and made available for system design, training development, T&E, installation and checkout, and fleet introduction.

3.2.2 Reference Models

Reference models provide the framework to build a common understanding and agreement for a system. A well-defined TRM is the building block that facilitates an abstract framework to generate a common understanding from both a horizontal and vertical system architectural viewpoint. This promotes a consensus among system participants as to what constitutes the technical architecture and identifies any issues requiring resolution. The TRM provides the basis for building a target system architecture as illustrated in figure 3-7.

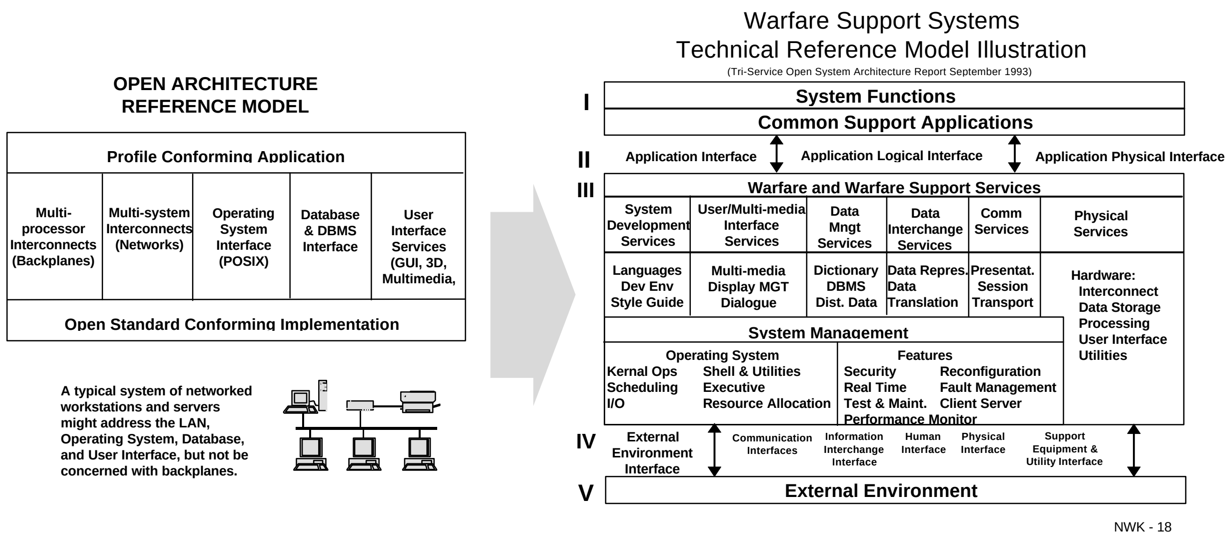

Figure 3-7 OSE Architecture Model Compared to Warfare Related TRM

Based on the target system architecture defined, determine which standards and standard profiles are needed. Select open system interface standards not only on the basis of openness, maturity, and satisfaction of performance requirements but also the capability to facilitate future technology insertion. Other considerations in the selection process include scaleability, portability, and interoperability. Open system interface standards usually have profiles of mandatory, optional, configurable, and extension features. Selected configurable features should not be vendor specific and vendor extensions should be avoided when selecting standards' requirements and features. This also applies during product selection; otherwise, the benefits and openness of the design are greatly reduced.

An example of the relationship between standards and a TRM is provided as figure 3-8. At this point there should be sufficient data to determine the effort needed to redefine interface requirements to address interoperability requirements. The ORD should be revised to determine if the defined TRM results need to be included in the ORD.

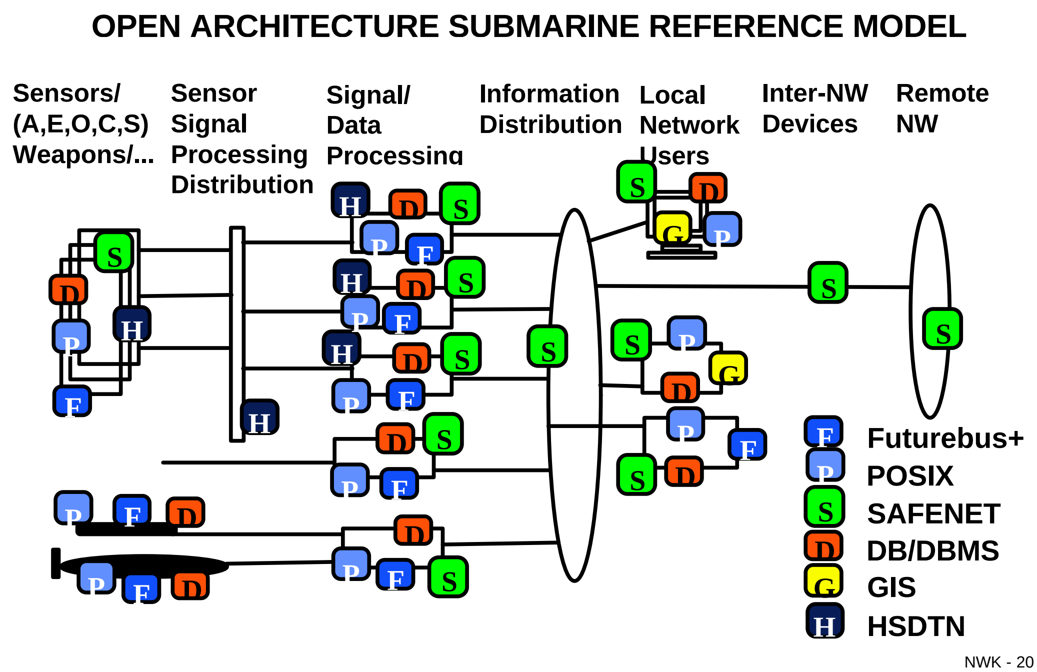

Figure 3-8 Sample TRM of an OSE Operational System

3.2.3 Integrated Product and Process Development (IPPD)/Integrated Product Teams (IPT)

IPPD is a systematic approach used by the program office for early integration and application of all disciplines for system acquisition and life-cycle support. A key proponent of the IPPD is the use of IPTs.

The IPT concept allows the program office to use functional experts to resolve technical and programmatic issues;[12] therefore, the IPTs must be comprised of personnel with the appropriate expertise and skill sets for the program. The IPT should consist of a cross-populated set of technical. Program management, and contracts personnel such as: ISEA/CFA, SSA. design agent(s), integrator, possibly industry/contractor, and other activities representatives as necessary to ensure an adequate and cost effective OSE product is procured and supported. In addition to the normal IPT functions, the following OSE IPT functions also apply:

- Defining the interface standards profiles of legacy system/products.
- Comparing the legacy profile to the Joint profile as needed.
- Generating an initial list of Navy/Joint open systems interface standards.
- Coordinating standard(s) profile w/ DISA center for standards (CFS) (TAFIM compliance considerations).
- Participating in an OSE market survey analysis.

- For example, the contracting officer (a member of the IPT) needs to be knowledgeable about the nature and impact of open systems. This knowledge must encompass the legal aspects of copyrights, contracts, and performance specifications (wording and tiering). The contracting officer must be available and prepared to work closely with the program office staff, ISEA/CFA, SSA, design agent, integrator, and other activities. The contracting officer must be positioned to quickly place and modify contracts as driven by changes to standards, product, product support, and service availability. These changes may result in the need to procure new item(s) or life-of-type buys. This implies additional testing and

[12] DoD 5000.2-R, 15 MAR 96, section 1.6.

coordination between the testing, integration, and support elements. Contracting actions can be expected to be more time critical than in conventional development acquisitions.

The following represents the type of questions the IPT should address as part of the functional design considerations.

FUNCTIONAL DESIGN CONSIDERATIONS
✓ Was the analysis successful in defining any lower level functional and performance requirements including functional interface and architectures?
✓ Have any interface impacts been identified between the legacy set of interface standards and those needed for potential change implementation?
✓ Have commercial specifications/standards changes been tracked and analyzed for impact?
✓ Has the standards listing been updated/coordinated at the Joint level to reflect new requirements?
✓ Have trade-off studies been performed on the current or recommended interface standards?
✓ Has a configuration management (CM) plan that addresses standards based, NDI and commercial item applications been developed and implemented?
✓ Has an initial logistics and supportability process (with its associated procedures) been defined?

3.3 Acquisition Strategies and Options

The processes performed to this point should provide the program office with a good understanding of the requirements; availability of products to fulfill these requirements; and alternatives for reducing risk. As performance requirements are finalized to reflect the initial market survey and trade-off studies, the accumulated information (including any identified products) may be used to develop alternative acquisition strategies. Using the data available, the IPT can determine whether to proceed with a full NDI/commercial item procurement; a mixture of developmental and NDI/commercial item; or a full developmental approach. Realistic cost-effectiveness data for each alternative acquisition approach should be postulated.

Figure 3-9 represents a simplified flow process for identifying the strategy and defining the options available to the IPT.

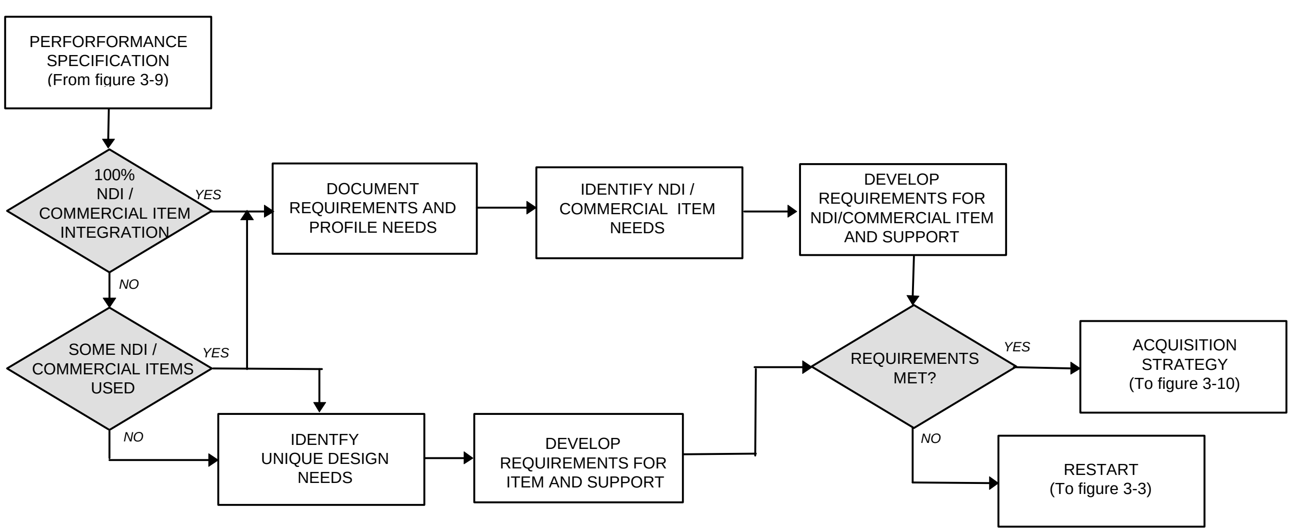

Figure 3-9 Process Flow: Identifying Acquisition Strategies

3.3.1 Acquisition Scenario Discussions

Using the best information available, the program office can select the initial acquisition strategy. The acquisition strategy may be refined as the requirements and specifications are developed for the RFP. Several different scenarios for acquiring products can be undertaken to achieve the same results. Several scenarios and three strategies that can be applied are listed below:

- Acquisition Scenarios
  - Government selects the standards and products then performs the integration effort.
  - Government selects the standards, the contractor designs or selects products and integrates the system.
  - Government and contractors share the responsibility of selecting the standards and integrating the products.
  - Contractor selects the standards and products then performs the integration effort.
- Acquisition Strategies
  - Purely developmental
  - Mixed developmental and NDI/commercial item
  - Pure NDI/commercial item integration

3.3.1.1 Government Selects the Standards and Products and Performs the Integration Effort

Under this scenario, the government, based on internally-held knowledge, makes and implements acquisition decisions. This approach depends upon the collective knowledge in System Command (SYSCOM) headquarters, warfare centers, or Navy laboratories. The government functions as design agent, systems integrator, producer, and installer. The government selects and specifies open system interface standards, profiles, and open system interface standards based commercial item products. The government then buys and integrates the products into the overall system. Making such standards and commercial item selections requires the government to make a strong, up-front investment (time and money) in personnel, training, and facilities.

This scenario presumes that government personnel have the necessary knowledge to perform and interpret market surveys to accurately define and implement a program. Initial market survey and analysis work are conducted during Concept Development and Demonstration/Validation. Additional market surveys are required as upgrades and product obsolescence are encountered. Associated with the market survey are trade-off studies required for reuse, reverse engineering, and re-engineering, process improvement, and creative procurement/acquisition strategies as required to take maximum advantage of the open system environment. A team of engineers, logisticians, acquisition planning personnel, and cost personnel is required to develop, conduct, and interpret trade-off studies.

The government must be postured to respond to standards updates, new standards, and the resulting impacts on purchased commercial item products. When changes to a standard directly affects products being procured, that change must be addressed. Impacts resulting from standards changes may affect software portability, software reuse, and faster technology insertion. System definition likely will take more time due to the need to perform trade studies, gather data, and so forth. System design may be faster due to commercial item availability and the existence of mature interface definitions.

3.3.1.2 Government Selects Standards, Contractor Designs or Selects Products and Integrates the System

Under this scenario, as in Section 3.3.1.1, the government makes the decisions regarding standards and profiles to be used in developing and integrating products. The contractor’s task is to design or purchase open system interface standards based products, then integrate them into a functional system.

In this scenario it is important to ensure that a contractor's stated choices of interface standards and profiles are accurately implemented in the products selected for purchase or development. If the interface

standards are not strictly adhered to, resultant products will not function together effectively or may be incompatible with upgrades built to the same standards. Contract data requirements lists (CDRLs) to provide interface information and product testing are important for risk reduction. The government needs to be able to accept or redirect the contractor's efforts and to insure that they do indeed result in a system that conforms to the interface as well as other performance requirements.

3.3.1.3 Government and Contractors Share Responsibility of Selecting Standards and Integrating Products

This scenario represents the middle ground followed by most acquisitions. To obtain the benefits of the best resources available when planning an acquisition, the government invites industry to participate in the interface and profile decision-making process, and the selection of compliant products. This may be accomplished through use of Joint working groups, funding of studies, and providing draft request for purchases (RFPs) for comment. This scenario requires the contractor to be familiar with legacy systems (for upgrades), the requirements, the technologies applicable to other aspects of the platform or system, and industry trends. The goal of this scenario is to apply this knowledge during the standards selection process, while considering the long-range plans for interface and product-level standardization within or across program and Service lines.

In this scenario it is important to ensure that a contractor's stated choices of interface standards, and profiles are accurately implemented in the products selected for purchase or development. If the interface standards are not strictly adhered to, resultant products will not function together effectively or may be incompatible with upgrades built to the same standards. CDRLs to provide interface information, and product testing are important for risk reduction.

To define and use evaluation criteria and conduct trade-off studies for selection of interface standards, technologies, and products, the government/contractor team must understand what are the applicable open system interface standards choices, the technologies, products, and relative costs, and what can, and cannot be accomplished. This knowledge base may not be easy to assemble. The range of risks and choices is bounded by the technologies, the standards and product maturity, and by market factors.

This scenario might occur if the goal of a program is to design an entire aircraft. Overall performance requirements (e.g., speed, range, payload, accuracy of navigation, crew size, and information to be provided to that crew) are set by government. The method of achieving those performance requirements, though, is not set. In some cases, it may be sensible to have the contractor, not the government, decide which open system interface standards, and profiles apply in meeting these performance objectives. Legacy items, and the standards, and profiles to which they were designed obviously must be accommodated. Government participation is critical during the entire life cycle.

Interface and commercial item decisions can be made prior to the final RFP release, concurrent with contract award, or after contract award. Some considerations for the selected options are:

- Prior to issuing the final RFP - Under this option, many different types of participants may become involved in the process of choosing the final interface, and commercial item products to be solicited. Contracts may be issued for support of such studies by one or more contractors in a consortia based working group situation. Alternately, a single contractor, acting as a consultant, may perform such studies. Academia such as university laboratories may participate as well. Navy warfare centers, and cost, and supportability analysts also should be part of the team. Studies performed by these participants may be used to develop a solid, and complete performance specification, including interface definitions, for inclusion in the final RFP. The greater the quality of participants, the better the quality of the ultimate specification. Award protests also should be diminished due to such broad participation in interface, and commercial item selection from the outset.

- Make selection part of proposal/award - In this option the Navy team must have the information to evaluate the proposals and make the appropriate product selections. This introduces risk by requiring the government to be knowledgeable in open system interface standards and associated products.

- After contract award - This may be an appropriate option when major system elements are not yet fully defined. However, this option allows for fewer inputs to the interface and commercial item choices, and thereby, greater susceptibility for contract modifications.

3.3.1.4 Contractor Selects Standards, and Products, and Performs the Integration Effort

Under this scenario, the contractor performs the analysis work necessary for standard, and product selection, and for system integration. A system design review (SDR) should be conducted to allow the contractor to present and prove the appropriateness of the standards and commercial item selected. Profile selection/development and production selection/development then become the subject of the preliminary design review (PDR) and the critical design review (CDR).

When the contractor is responsible for open system interface standard and product selection, the following SOW language may be employed. The language presented supports the market analysis that should provide the government with needed information for review and approval.

> **The contractor shall perform trade studies and market surveys comparing open system interface standards and products being considered for use. The market survey shall include a discussion of the availability of commercial item products and their ability to meet requirements and supportability plans, including spares procurement and lifetime product repair. The market survey also shall provide advance planning for replacement of obsolete products. For hardware, the market survey shall include multiple product sources at the functional lowest replaceable unit (LRU) level and identify whether products are pin-for-pin interchangeable (i.e., require software changes for use of the replacement product). For software, the market survey shall include products that are open system interface standards compliant when resident on hardware products being evaluated and selected. The contractor shall justify ultimate product/design selection and provide supporting documentation as a technical report and presentation to the government for approval prior to proceeding with design. In the event that the interfaces and/or products selected do not meet system requirements, the contractor shall be prepared to provide technical and programmatic data necessary for obtaining any required waivers. The contractor shall perform or cause to be performed, requisite testing to ensure conformance of developmental and commercial item products to selected standards and profiles.**

Without an understanding of the implications of each of the standards, profiles, and products considered and not considered by the contractor, the government's review of a contractor's selections cannot accurately address analysis, cost effectiveness, or appropriateness. This scenario requires the contractor to be familiar with legacy systems (for upgrades), the requirements, and technologies applicable to other aspects of the platform or system, and more importantly, industry trends. Nonetheless, when the government team does not have access to requisite information and skills, this may be a good strategy.

In this scenario it is important to ensure that a contractor's stated choices of open system interface standards and profiles are accurately implemented in the products selected for purchase or development. If interfaces are not strictly adhered to, resultant products will function together ineffectively or may be incompatible with upgrades built to the same standards. CDRLs to provide interface information and product testing are important for risk reduction.

3.3.2 Acquisition Strategy Considerations

Risk can be mitigated by generating a draft RFP which includes a draft statement of work (SOW) and performance specification which could be forwarded to interested industry participants for comments. Industry would be solicited to provide inputs/suggestions on the RFP to the government; thereby, enabling the program office to identify standards, standards profile considerations, and associated products capable of meeting the requirements which were not identified during the market survey. Additionally, industry may identify problems among commercial products currently being fielded or with previously stipulated requirements and technology that had not been known or considered. There is a drawback to this approach. A manufacturer may mistakenly overstate the capabilities of their product, a product they recommended for integration, or understated another manufacturer's product.

The following considerations are typical acquisition strategy questions a program office should take into account when preparing to define and document an OSE acquisition program.

ACQUISITION STRATEGY CONSIDERATIONS

- ✓ Are any NDI products available to meet the needs of the program?
- ✓ Do sufficient commercial item products exist to proceed with full integration?
- ✓ Do commercial item production schedules meet program needs?
- ✓ How are the commercial items supported and do they meet program needs?
- ✓ Are there any second source/multiple vendor capabilities?
- ✓ Have sparing requirements been identified and are they ample to meet program needs?
- ✓ Has a logistics analysis been performed including cost-effectiveness study?
- ✓ Have training requirements been addressed and solidified?
- ✓ Have software support requirements been determined?
- ✓ Has a risk assessment been performed?
- ✓ Have documentation needs been established (minimum data to manage and support program)?
- ✓ Will a level of repair analysis (LORA) be accomplished prior to RFP or will the contractor be required to perform it?
- ✓ Have the T&E requirements been defined?
- ✓ Does sufficient conformance and interoperability test information exist?
- ✓ Have the commercial item product(s) life cycle been determined?
    - How often is the item upgraded?
    - Is it part of a product line?
- ✓ Does the funding profile meet program needs and does it consider the potential for evolutionary acquisition upgrades? (e.g., every 3-5 years?)
- ✓ Does sufficient commercial item related training data exist or will new documentation be needed?
- ✓ Will the NDI/commercial item need repackaging to fit the environmental profile?

3.4 RFP Generation

Once the requirements, performance specification, and acquisition strategy have been defined, documented, and approved, the next step is transferring this data into a RFP consisting primarily of a SOW, performance specification, and associated CDRLs. The type of information addressed in the RFP depends upon the type of acquisition strategy selected. A common approach may be for a prime integrator to out source and integrate commercial items into an end-item. Potential sources of assistance in generating RFP related information include:

- Acquisition policies, directives, and documentation requirements are addressed in DoDD 5000.1, DoD 5000.2-R, and the draft SECNAVINST 5000.2B.
- Additional assistance can be found in the Naval Sea Systems Command's (NAVSEA) electronic Master Acquisition Program Plan (MAPP) and on-line via the Internet and the acquisition deskbook.
- The SYSCOMs also have acquisition reform agents to assist program offices and acquisition engineers in generating and staffing the RFP.

The generation and solicitation processes are not substantially different for acquiring open system products. DoD is simplifying the acquisition process and compressing schedules to achieve cost savings. Additionally DoD is fostering more commercial participation. The intent is to reduce restrictions, eliminate large volumes of redundant documentation and delivery items that describe the end item. In cases of open system commercial items, availability of DoD unique documentation should not normally be required in today's acquisition environment. The contractor is now given more latitude in how documentation and product descriptive data is presented and forwarded to the government. The key RFP documentation is the performance-based specification, SOW, and CDRL items, but these documents should be developed expressing the requirements and documentation for an open systems acquisition. Depending on the acquisition strategy selected (full development, some mixture, or all NDI/commercial item products), the degree and content of technical and programmatic documentation required will vary. In each case the main factor that must be considered is how well is the open systems interface requirements and related data needs are defined in the solicitation package. A draft release of the RFP should help the program managers find contractors who either have an open systems experience or at least understand the OSE prior to a final RFP release. The RFPs should provide incentives for contractors to provide and maintain an open systems approach. A program acquisition striving to achieve an OSE should take a cumulative, life-cycle approach to open systems and not a quick fix approach.

The IPT should play a major role in the development of the RFP, not only in the area of specification generation but also in development of the SOW and CDRLs. The SOW should address such items as: requirement of the contractor to provide an open system implementation and migration plan, identification of the contractors process for conducting a market survey and how the survey results will be presented, escrow account(s) considerations for selected products, and IPPD/IPT involvement. When developing the RFPs section C, Instructions to Offerers, a requirement should be inserted for the bidder to provide evidence of open system experience and understanding or provide a sample task that requires the bidder to respond to sample task using an open system solution. The instructions should also have the bidder identify:

- Contractor's opinions and process for standards profile applications and conformance in their design.
- How the design is an open systems architecture.
- Contractor's life cycle support strategy.
- Technology refreshment program being employed.
- Adherence to an open systems approach.
- Strength of market knowledge.
- Contractor's conformance management approach.

Figure 3-10 provides a synopsis of the process for integrating the performance requirements and acquisition strategy into the RFP.

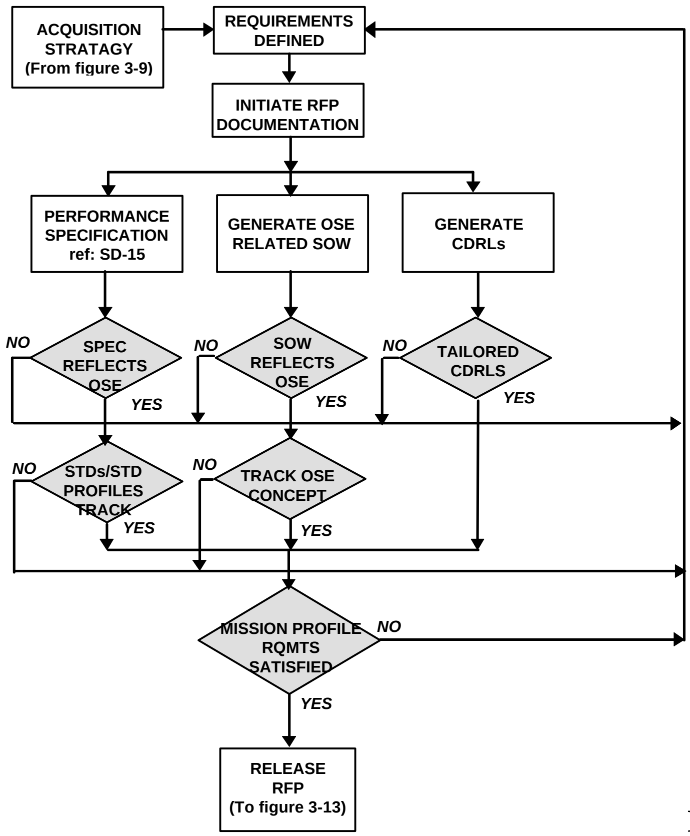

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Figure 3-10 Process Flow: RFP Generation

If the procurement comprises a full application of NDI/commercial item products, the RFP should specifically address the integration of these products, conformance and interoperability testing verification to selected standards, and supportability issues. No matter what the degree of NDI/commercial item integration, compliance to internal and external open system interface standards, along with conformance and interoperability testing is essential. The main parts of a RFP (SOW, CDRL, and performance specification) drive the acquisition effort in terms of cost and time. Historically, a detailed SOW and a *build-to type* specification provided definitive information for system development based on Federal, DoD and Military Standards requirements. In today's open system acquisitions, the emphasis is on using commercial standards and specifications. The process for developing the main components of an RFP for an open system acquisition is discussed in the following sub-sections.

3.4.1 Performance Specification

A performance specification defines the functional requirements for:

- the item and the environment in which it must operate,
- the interface and how it will be tested, and
- the interchangeability characteristics.

A good performance specification[13] contains requirements that are quantitative rather than qualitative, verifiable, and material and process independent. DoD has defined, as part of the acquisition streamlining effort, the order of precedence of specifications for DoD acquisitions (figure 3-11).

GROUP I Documents mandated by law or regulation pursuant to law	**GROUP II** Performance Documents	**GROUP III** Detailed documents	**GROUP IV** Standards, specifications, and related publications issued by the government outside the military or federal series for the non-repetitive acquisition of developmental items
• OSHA or EPA regulations	• Non-government standards • Commercial Item Description (CID) * • Federal specifications • Standard performance	• Non-government standards ** • Federal specifications • Detailed specifications ***	• Purchase descriptions • Product descriptions • Program peculiar or system specifications
* By definition a CID is a performance specification. ** Non-government standards are not necessarily performance-based. They should be examined individually to determine if they are performance-based. *** The application of detailed specifications and military standards requires a waiver.			

Figure 3-11 Specifications Order of Precedence

Depicted in figure 3-12 is a high level overview of a typical open system based specification development process. The operational need forms the basis of the start of a open systems based performance specification. A set of derived requirements are identified from the operational need (MNS and/or ORD) and a set of derived requirements is generated. At this point, a minimum list of interface standards can be developed at both the Service and Joint level, thus determining the initial functional requirements that require specification in the contract. As part of the performance specification development process, program offices need to evaluate interface standards in terms of their functional profile, determine the minimum set of mandatory requirements, and assess the optional profiles and associated extensions to determine usability and interoperability. The performance specification should clearly identify the standards selected and the profiles necessary to achieve conformance.

Selected standard profile(s) should be addressed in the performance specification to the degree necessary to ensure enough information is passed to the contractor to adequately perform conformance testing, achieve interoperability, compatibility, scaleability, and performance. The standards and their profiles integrated into the specification should be compared to the architecture requirements of the acquisition program (both at the Service and Joint levels) and modified as required to insure interoperability and compatibility. At this point the program office can decide whether other Service NDI/commercial item products can be of use and identify any discrepancies between standards selection and profile restrictions. Also an initial market survey should be performed to determine implementation and migration opportunities of commercial items to meet the functional needs of the design. This process should greatly reduce risks in terms of performance, interoperability, and in the long run cost-effectiveness and schedule risks. The results of the market survey should be used to refine the RFP documentation especially the performance specification. Sufficient information should be available to start determining if sufficient products are available in the market place and if they have the support to meet the programs requirements or whether a full or partial development effort is needed. The specification may need to be refined to address those portions of the design that need development. The test requirements section of the specification should likewise address NDI/commercial item applications to the design. No matter how the functions are achieved in the design, the need to adequately test for interface conformance remains a critical part of the specification requirements.

[13] SD-15, Performance Specification, OASD, 29 June 1995.

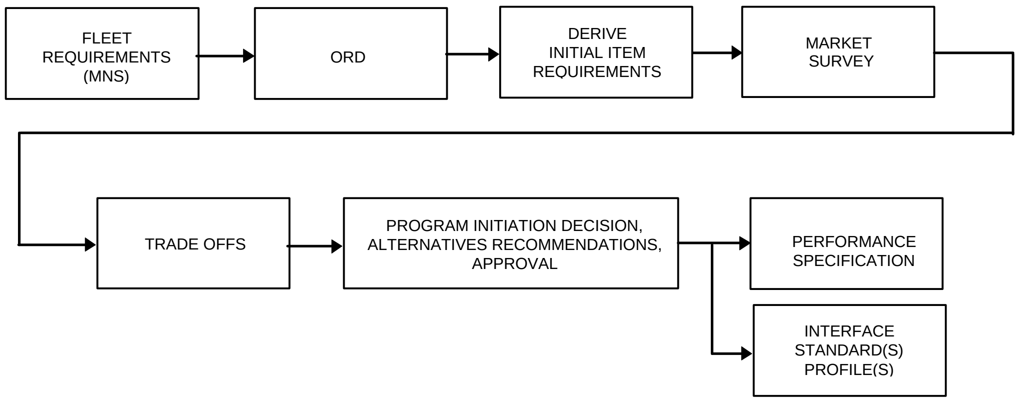

Figure 3-12 Process Flow: Performance Specification Development

Typical considerations a program office evaluates when generating a program's performance specification are provided below.

PERFORMANCE SPECIFICATION CONSIDERATIONS

- ✓ Have requirements been specified so as to promote full and open competition?
- ✓ Have the minimum requirements or thresholds been stipulated?
- ✓ Have thresholds been defined?
- ✓ Have constraints been identified and addressed within the specification in a clear manner?
- ✓ Are requirements stated in a quantitative versus qualitative manner?
- ✓ Have specifications been stated in terms of function and performance vs. "How To", and design requirements (environment, supportability, etc.)?
- ✓ Are interfaces defined in sufficient detail to allow interchangeability?
  - Standards and standard profiles (mandatory and optional features used by the system)?
  - Interface conformance (testing, test reports) incorporated into T&E efforts?
- ✓ Was the specification developed using market research in order to leverage commercial products?
- ✓ Have the standards and standard profile needed to meet the derived set of requirements been checked against systems/products that must interoperate to ensure no unique application of the interface exists elsewhere in an architecture that could compromise interoperability?
- ✓ Does the specification meet acquisition streamlining criteria?

3.4.2 Statement of Work (SOW)

The SOW or statement of objectives (SOO)[14] (hereafter referred to as SOW), along with a performance specification and associated CDRLs, provides a definitive scope of effort for the system developer/manufacturer. The SOW defines the types of information/documentation required; types of reviews to be conducted; the testing required; test data requirements (traceable to the performance specification and test and evaluation master plan (TEMP)); and logistics requirements (logistics support analysis (LSA), reliability/maintainability/availability (RMA), training, supply support requirements, etc.). OSE requirements are addressed to include the use of commercial standards when feasible. The SOW also contains contractor requirements for configuration management, and quality assurance, along with program management requirements, policies, and procedures.

It's imperative that in an open systems acquisition that the SOW clearly identify tasks such as:

[14] MIL-HDBK-245D, 3 APR 96.

- establishment of a conformance management program,
- identifying and generating data requirements for product integration,
- product CM planning and tracking, and
- defining how CM and quality assurance (QA) requirements will be invoked on vendor/ subcontractors.
- identify, establish, and implement design/baseline control methods/processes
- define OSE related requirements including logistics and supply support concepts and methods for transferring and accessing logistics/support data.

The integrator, whether a DoD or contractor agency, will need to combine data from several different products into usable training and maintenance documentation. Operator and maintenance manual requirements can be leveraged from data already available from commercial producers. The data integration effort can be part of a solicitation and priced for either the Integrator/Prime contractor or government agency as warranted.

Requirements for the development and support of training data and devices needs to be stated in the SOW. In some cases, the major issue to consider for including a work task in the SOW may be to generate the training data for an aggregate set of products from a multitude of OEMs that comprise the design.

The SOW has to include requirements for NDI/commercial item analysis and trade-off studies. This includes performance, product availability, conformance, and interoperability test data (including simulation and modeling results), design criteria and associated interface standards, and production line plans for each vendor and product. Other SOW considerations are requirements for the contractor to provide the standards/profiles for each selected interface; thereby forming a minimum set of profiles that baseline the design. Typical open system related SOW considerations are:

STATEMENT OF WORK CONSIDERATIONS
✓ Does the SOW encompass the open systems program requirements for qualifying commercial items? ✓ Do requirements exist for the contractor to establish a conformance management program? ✓ Does the conformance management program addresses how the contractor will: • fix non-conforming behavior or restrict other components use to features that do conform; • require engineer conformance into anything that will be developed; and, • document and manage by the specific interfaces selected? ✓ Have open system product Level of Repair (LOR) requirements been addressed? ✓ Have sparing requirements for NDI/commercial items been addressed? ✓ Have all work efforts been stipulated for defining, performing, and documenting all necessary OSE related test requirements specified in the performance specification including: • interoperability testing; and, • conformance testing? ✓ Is there a requirement for the prime/integrator to invoke commercial CM and QA standards where applicable? ✓ Is documentation of standards profiles applications required and are specific contractual mandates addressed? ✓ Is test data verification required (vs. claimed compliance)? • Are third party test results available? • Does the test data directly correlate to product in question or to product line? • Do the test data results provide interface profile conformance or compatibility verification? ✓ As components evolve, are techniques for assessing their interface conformance addressed? ✓ If depot level support is required are tasking and periods of performance clearly defined? ✓ Have technical manual and training requirements been identified for commercial item integration support? ✓ Does the SOW address contractor scheduling and planning? ✓ Does the SOW address reliability and risk management planning and metric task efforts?

3.4.3 CDRL (Contract Data Requirements List)

Data item deliverable cost factors can, in some cases, overshadow the actual product costs. DoD streamlining and standardization efforts have focused on the cost versus data value issue and evaluated the depth and complexity of the current CDRL package versus cost effectiveness. The focus has shifted to acquiring the right amount of data to ensure a cost-effective and performance capable product that is supportable and based on commercial standards, specifications, and CIDs. The program office needs to tailor deliverables to fit need, and where possible, to fit widely accepted commercial specifications, standards, and processes. Only essential data requirements to baseline and control products should be required of the contractor. The program office should review data requirements and the contractor's format wherever feasible. The following checklist consists of typical questions that need to be asked when generating a CDRL package for an OSE acquisition. The CDRL package should be generated in conjunction with the development of the open system based performance specification and associated SOW.

CDRL CONSIDERATIONS

- ✓ Have DIDs associated with commercial standards and/or specifications been used?
- ✓ Have DIDs been tailored to allow industry involvement?
- ✓ Does the CDRL package address all OSE related SOW work areas such as:
    - configuration management and control of baseline/reporting requirements,
    - conformance management plans,
    - technical data including,
        - vendor documentation,
        - documentation of standard profile(s),
        - interface and interface conformance data,
        - commercial item operator and maintenance manual(s),
        - interface features used by the system, i.e., standard (mandatory and optional) features used by the system,
    - logistic support analysis reports,
    - quality assurance plan and processes,
    - test and evaluation plans and reports (conformance, interoperability, portability, scaleability, acceptance, and regression testing, etc.),
    - training plans and reports,
    - maintainability and maintenance data,
    - reliability data and documentation (analysis test results, e.g., finite-element and boundary-element analysis (FEA/BEA) assessments), and
    - electronic data/documentation requirements/reports?
- ✓ Have sparing requirements and data been defined and documentation incorporated in the CDRL package (important in mixed and full development efforts)?
- ✓ Have adequate requirements been defined for repairable items?

3.5 Contract through Deployment

The Navy is rapidly changing to an evolutionary acquisition approach which includes cyclical acquisitions incorporating upgrade/field changes or new systems by deployment battle groups. To field a system that meets operational needs in a cost effective and supportable manner, program offices and associated IPTs will need to constantly track and update the program profiles and requirements to fit emerging technology and product line variations. Once a program has adequately defined its requirements and generated the technical documentation to procure, the RFP is issued and a process put in place to evaluate responses to the RFP. The down-selection of submitted proposals in terms of an open systems acquisition versus a traditional full development acquisition requires attention to different discriminators than in past acquisitions. The Technical Evaluation Board (TEB), normally convened to evaluate the proposals, should now include the IPT to ensure the OSE and related standards knowledge base is available to properly evaluate the proposals.

The process for moving the program from the high level performance specification to a fielded system is depicted in figure 3-13.

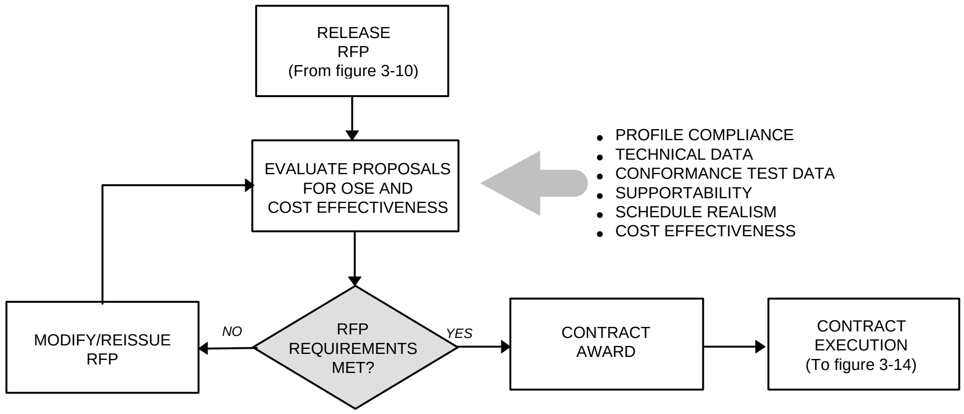

Figure 3-13 Process Flow: Contract Award

The evaluation by the TEB needs to focus not just on the prime contractor/integrator but on the commercial items that make up the system/equipment. Systems will consist of multiple OEM products integrated into an overall design, so the depth of evaluating a proposal may necessitate suppliers and/or vendors participation. Access to and value of available technical data will be a premium factor. Compliance to the standards of the external interfaces of the final assembly and the internal interfaces of the commercial items/LRUs that make up the product is very important. Schedule, commercial item availability, and support items are essential in the decision process. The ability to track all the commercial items that make up the final end item in terms of interface application, changes, product line modifications, and interoperability are likewise essential.

Some items of consideration when selecting a contractor or integrator for an OSE program effort are provided below.

CONTRACTOR SELECTION CONSIDERATIONS
✓ What is the contractor and vendor's past performance in the OSE?
✓ Is a quality assurance process in place for both contractor and vendors?
✓ Has the contractor specified an adequate method to measure conformance to standards?
• Are appropriate alternatives in place to handle correction of non-conformance?
✓ Does the contractor/integrator have a method in place to track products and designs as it relates to conformance to the standards and standard profiles?
✓ Are vendors capable of OEM repair? What is their history in meeting repair or warranty requirements?
✓ Does the contractor have a plan to track interface applications integrated into the system over a period of performance?
✓ Has conformance testing been conducted on parts/components/LRUs that are in use commercially and which fulfill functional requirement and interface standards?
✓ Does the current production output meet the program needs?
• How much of the market share is the system need?
• Is the program the only reason for a new production run?
• Are the products real (not vaporware)?
✓ Have the product update cycles and support time been defined?
✓ If NDI/commercial items are being integrated, have the life cycle support times been established?
✓ Does the choice of open system interface standards products influence out-year support?
✓ Are there second sources of products for the functions being profiled?
✓ Have built-in test and built-in test equipment (BIT/BITE) requirements been addressed?

CONTRACTOR SELECTION CONSIDERATIONS
✓ Are computer aided design and computer aided manufacturing (CAD/CAM) drawings available? Does electronic access to vendors CAD/CAM exist?
✓ Is reliability data available?
✓ Are technical manuals available and do they meet program requirements?
✓ Are warranties to be provided? Do they meet program needs?
✓ Have training considerations been met?
✓ Have all environmental profile requirements been addressed and can they be met?
✓ Have all supportability profile requirements been addressed and can they be met?
✓ Does the contractor have a plan to mitigate the risk factors identified as part of the proposal review?

3.6 Contract Execution

Figure 3-13 identifies a contract execution function performed prior to deploying an OSE related product. This function and associated processes are represented in Figure 3-14. The figure illustrates that, upon contract award, well defined systems engineering efforts should be implemented by the contractor (with the IPT acting as oversight) in order to ensure proper transition of the OSE acquisition from a design and integration state effort to a deployable system. As part of the source selection process and prior to executing the OSE oriented contract package, the government, using available IPT expertise, should have evaluated the contractor's capabilities and the past performance of proposed and associated LRU vendors. Considerations should have also included the proposed contractor/manufacturer's reliability and supportability factors, availability of test conformance data for proposed NDI/commercial items, and identification of any migration options of the proposed design. Upon applying the various weighting factors of the selection criteria, a contract is awarded and execution plans put into place.

No matter which acquisition strategy was selected or who is the contract performer, a solidification of the design and associated interface standards, standards profiles, and selected solution of products needs to be achieved. In some cases, the selected contractor (or the government in some acquisition scenarios) may find factors have changed, such as:

- Commercial items originally selected may no longer be supported.
  - Technology advancements may have been over taken events.
  - Product manufacturing or sparing capabilities may no longer exist or meet program life cycle schedules.
  - Product lines may no longer be in compliance or compatible do to changes of internal design.
- Funding profiles may have necessitated a change of performance requirements.
- Vendor or supplier availability could have changed.

The contractor, working in conjunction with the government (IPT), should use the market survey and trade-off analyses (including cost) process to verify that the agreed upon approach and design is the best value in terms of functional performance, supportability, and cost-effectiveness.

The contractor needs to verify to the government that the selected NDI/commercial items being integrated:

- meet all specified requirements;
- are products that conform and are compliant to the specified interface standards and standards profiles; and
- have conformance test data provided to the government or conduct tests to ensure conformance and compatibility prior to acceptance of the system/product by the government.

If the test data does not exist or contractor test capabilities are insufficient to verify/validate conformance and compatibility of the product(s), then either the contractor or the government must identify the facilities that

can perform the verification/validation of the product(s). It is important that the interface standard(s), test procedures, and associate test results be well documented to establish the baseline for the deployed system.

Any shortfalls identified in finalizing the design must be documented and addressed. Solutions rectifying the shortfalls must be implemented prior to proceeding to acceptance and deployment. Potential solutions include replacing products that no longer are available with a product that meets the specified form, fit, and function factors but may not have been selected because of being more costly, having fewer optional features than the previous product, or having less technical or supportability data (i.e., technical manual) available. This may require the program office and the IPT revisit the specified requirements (including the ORD) to see if a relaxation of the specified requirements or programmatic needs could be permitted to allow use of the product without compromising the system's objectives and thresholds.

Once the baseline is finalized and integration and testing is complete, the product can transition into life cycle maintenance. The contract execution function should start the efforts to put supportability factors and processes in place. These include but are not limited to depot support, sparring, implementation of the configuration management plan, and tracking of the baseline and technology factors.

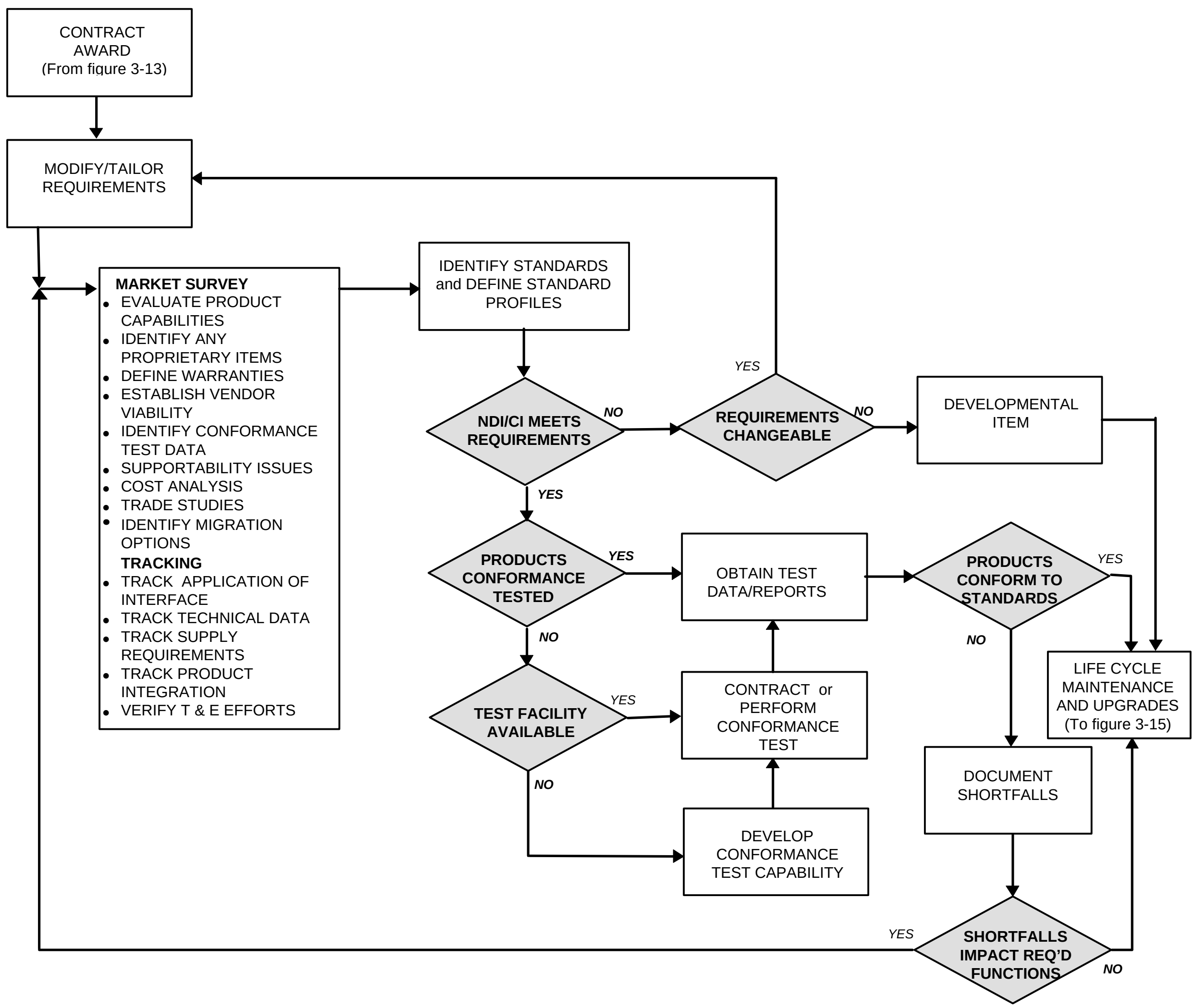

Figure 3-14 Process Flow: Contract Execution

3.7 Life Cycle Maintenance and Upgrades

NDI/commercial item product obsolescence often drives how maintenance is accomplished. Maintenance is more likely to come in the form of product upgrade. Market surveillance of OSE products and emergent OSE technologies is necessary for support and upgrade of systems in all environments. In many cases, it may be helpful to closely monitor the commercial standards being developed. Figure 3-15 provides an overview of the life cycle maintenance and upgrade process.

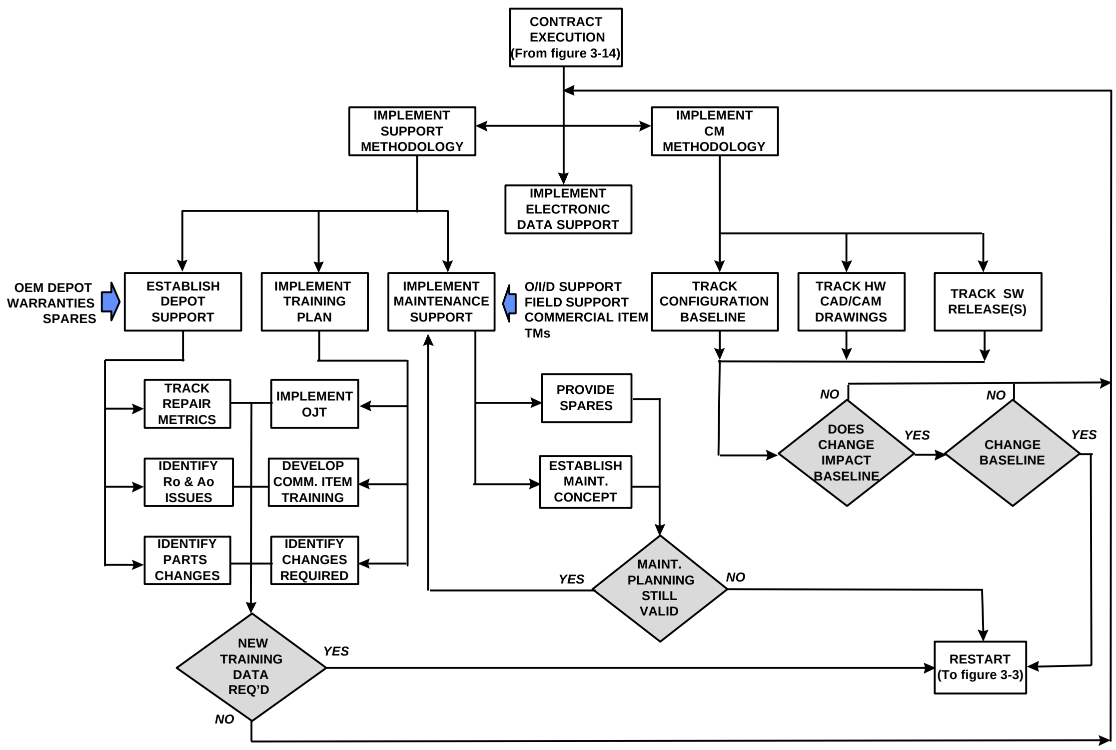

Figure 3-15 Process Flow: Life Cycle Maintenance and Upgrades

The initiation of the life cycle requirements addressed in figure 3-15 starts at the very beginning of the open systems acquisition process as part of the development of the MNS/ORD functional, environmental, supportability, and product requirements. As the functional profile is derived from the MNS/ORD, so are the environmental and supportability profiles. As the design and standards selection are refined and products are evaluated, so are the life-cycle support issues. A major part of the market survey is in the area of product supportability of the technologies and products under consideration. The key to successful reduction of program risks is how well life cycle factors are predicted and planned.

Traditionally DoD's approach was to define the unique interfaces and processes in a very detailed critical or prime item developmental or product specification that required extensive testing to verify function performance and quality control for the production and support of the end item. The components at both the piece part and end item level were usually developed from scratch or unique enough to require extensive out year supply support and individual program related training for operators and maintenance. Parts support for a full development acquisition were/are usually not cost-effective or usable in other systems/program efforts. The open system life cycle support stems from the use of standards that are being used in the market place for a variety of uses. The hardware and software components that implement the standard(s) can be acquired and integrated to meet

functional needs of the system. The supply support for the OSE system component products will generally be available for a shorter period. The length of available supply support will be driven by the commercial market place and rate of product change. Stockpiling components is not usually a cost-effective approach. As commercial items are more freely integrated into the main stream of DoD systems, the supply support, documentation, and training support requirements will have to keep pace with the commercial marketplace. OSE related training requirements (versus established Navy Training techniques) may need to be closely evaluated and tailored. Training such as: computer based training (CBT), video teleconferencing classes (i.e., upgrades), video cassettes, and other types of media should be considered in addition to or in lieu of traditional training classes. Training by standards and associated fielded products (i.e., software packages) may also be appropriate. Section 4 discusses in more detail the open system considerations that should be addressed when acquiring an open systems product.

Some considerations when planning life-cycle maintenance and upgrades support for an open systems are provided below.

LIFE CYCLE MAINTENANCE and UPGRADE CONSIDERATIONS
✓ Does the current life-cycle maintenance system sufficient meet the new requirements?
✓ Is the maintenance concept sufficient to meet OSE needs?
✓ Are the training requirements already in place capable of meeting open systems requirements?
• Are the commercial item manuals sufficient for operator and maintainer requirements?
• Is contractor training available? Is it cost-effective?
• Is embedded training available and is it part of the design?
• Is CBT an option and available?
✓ Is technical data available in digital form? Is it required as part of the contract?
✓ Is the warranty adequate?
• If modifications are required, is the warranty affected?
• Does a warranty need negotiation?
✓ Is the depot providing adequate and timely repair? Is it cost-effective?
✓ Is commercial support more cost-effective?
✓ Are supply support plans meet OSE requirement?
✓ Is an escrow account available?
✓ Have life-cycle maintenance impacts been addressed for:
• interface standards stability,
• product application and stability of interfaces,
• technology and standards development/revisions,
• Joint Service application, and
• changes to system interface standard profiles (external and internal)?
✓ Have leased options for support been considered and is it a cost effective option?
✓ Are other Service/Joint programs using the same commercial items?
✓ Are other Service/Joint program maintenance support capabilities for these commercial items available?
✓ Is conformance tracking plans in place and being implemented?
✓ Do related OSE technical changes (i.e., engineering change proposals (ECPs), specification change notices (SCNs), etc.) consider life-cycle support issues?

4.0 SUPPORTABILITY

Department of Defense (DoD) Regulation 5000.2-R requires that supportability factors be stated as performance requirements in the contract. This section discusses the underlying integrated logistics support (ILS) elements and related disciplines necessary to develop these performance specifications for support in the contract. The discussion focuses on the changes in approach and implementation required in an open system environment (OSE). This section provides some insight necessary to implement a minimum risk open system support system consistent with Navy acquisition policy. The disciplines discussed are provided in table 4-1.

DISCIPLINE	REFERENCE to DoD 5000.2-R
Design Interface	Paragraph 4.3.4
Maintenance Planning	Paragraph 4.3.3.1 and 4.3.3.2
Manpower and Personnel	Paragraph 3.5.2
Supply Support	Paragraph 4.3.3.4
Support Equipment	Paragraph 4.3.3.4
Technical Data	Paragraph 3.3.4.5 and 4.3.3.3
Training and Training Support	Paragraph 4.3.3.4

Table 4-1 ILS Disciplines with Reference

The disciplines are discussed in this section in terms of considerations that need to be addressed when conducting an open system interface standards based acquisition. Discussions regarding open system supportability approaches, methodologies, and recommendations address the unique aspects of an open system interface standard acquisition.

When using open system interface standards, a best value approach should be pursued to balance cost, performance, schedule, operational readiness, and supportability. The use of open system interface standards promotes an environment in which interface conformant products from multiple original equipment manufacturers (OEMs) can be integrated to form functional systems. Supportability issues must be part of the criteria evaluated during the selection of the system architecture. It is imperative that detailed product support planning occur concurrently with the start of the development process. Commercial product baselines are continually migrating because industry is releasing new products every 18-24 months. Support must be defined, planned, and purchased for each commercial product baseline change incorporated into a DoD system.

4.1 Design Interface

In a traditional development program, design interface started as the design was developed and tended to consist largely of logistic support analysis (LSA) tasks and participation in formal MIL-STD-1521 design review activities. Rarely did the ILS Manager or ILS staff have opportunity to analyze potential designs and compare their inherent supportability parameters, constraints, and costs in a timely enough manner to affect them significantly. The traditional situation was waiting for the design engineers to be reasonably happy with the result of their efforts prior to release of drawings to the "ilities" team for their initial review. Generally, the "
review was too late in the design process to cost effectively impact supportability shortfalls. Involvement of the ILS team usually started after the milestone II decision. By this time, about 85 percent of product support costs have already been established by design decisions.[15]

In an open system environment, choices can and must be made between competing architectural possibilities prior to program commitment to a system architecture, a set of standards, and standards profiles. Once the architectural decisions have been made, most of the big drivers for product support methods and costs are

[15] James V. Jones, *LSA Handbook* (Blue Ridge Summit, PA: TAB Professional and Reference Books, 1989), 17. Support costs determined: 70% by end of concept phase; 85% by end of system definition; and 90% by the end of full scale development.

in place. The architectural decision is generally a technology choice, and in most cases, an actual product type decision. The known linkage between specific standards, profiles, and products, tied to the rapid availability of these products and their related support structures, can create opportunities for substantive timely input to architectural decisions.

Supportability inputs to design considerations start as the initial requirements are being established. Functional reference models can be created and used to model competing architectures and supportability options. Supportability options abound until the final architectural decision has been made. Inputs to the decision process such as market surveys, architectural comparisons, and tradeoff activities culminate in the use of supportability analyses and corresponding life cycle cost (LCC) forecasts. The principal methods of influencing system design are to become proactive in the market survey and trade-off studies.[16]

Once the system architecture has been selected, the design interface task changes to ongoing interaction with the engineers participating in planning and implementation of system refinements and support. In an open system environment, evolutionary acquisition and upgrade as an element of product support are expected to become normative. Multiple baselines will need to be defined and supported. The design will change as will the associated products and standards. Ongoing interaction among the ISEA/CFA, SSA, design agent, test facility, and others, will be necessary to refine and enable effective support and upgrade of systems at all user locations. The dynamic nature of commercially based open systems requires continuous design interface throughout the system life cycle.

In the past the Navy has relied on build-to-print and source control drawings to procure spares and maintain deployed systems. With the advent of frequently changing commercial product families and just-in-time procurements the roles of the ISEA/CFA and SSA become more pronounced. The use of specified form, fit, and function requirements, performance requirements and vendor item drawings (VID) will become more prevalent. The ISEA/CFA and SSA (or prime contractor) will have to track and test the changing product family members as they progress from one revision to the next in order to support production or sparing requirements. The VID should be monitored to ensure that it includes the newest product in the evolving product family.

Bridges provide pathways for compatibility. They give the ability to have some portions of a computer-based product use a legacy architecture (e.g., AN/UYK-44 or Versa Module Europe (VME) products) while upgrading other portions, achieving improved functionality, and enabling gradual upgrade of the computer resource to newer and more powerful OSA standards. The bridged products within an equipment or system interoperate, which is to say they can intelligently exchange data and not interfere with each other's functionality. To develop bridges between DoD unique instruction set architectures and commercial OSA architectures, DoD must either spend development dollars or offer commercial developers the opportunity to upgrade a large enough number of DoD unique computers to justify the expenditure of private sector development funds.

If DoD is to leverage its dollars (i.e., in the tactical computer resource arena), it must search out and use cost-effective opportunities to *standardize at the architectural as well as product level, not just within DoD, but also with the commercial marketplace.* If the commercial marketplace is using vast quantities of products that conform to OSA standard XYZ, then DoD should try to standardize on these products too. The result will be ready availability of product support infrastructure and services, and timely availability of upgrade paths, all based on commercially based investment.

Typical design interface considerations are listed below.

[16] Refer to section 5.1 and 5.2 for additional information.

DESIGN INTERFACE PLANNING CONSIDERATIONS
✓ Involvement of IPT in all facets of design interface considerations. ✓ Maturity of the architecture. ✓ Identification of Standards, standards interfaces, and associated selected standards profiles. ✓ Determination that sufficient data exists and is available (e.g., detailed profiles and test data) to translate the functional needs of the design into a technical reference model (TRM), performance specification, and statement of work (SOW). ✓ Have functional, environmental, supportability, and product technical requirements been addressed by the IPT? ✓ Modeling and simulation efforts employed that evaluated alternative approaches/designs and verified interoperability and integration factors to product needs. ✓ Cost -effectiveness studies performed prior to final selection of design interfaces.

4.2 Maintenance Planning

Maintenance planning is the process that evaluates system design iterations with respect to the program's mission, operational availability (A_o) requirements, and costs in order to define and refine the maintenance concept. In a developmental program that uses open system interface standards, maintenance planning is the same as in traditional developmental programs. However, for open system interface standards based non-developmental item (NDI) and commercial item system integrations, the maintenance planning task is to ensure cost effective, efficient product support. This requires innovative and creative planning. Figure 4-1 provides a theoretical overview of maintenance planning and its relationship to other elements of supportability.

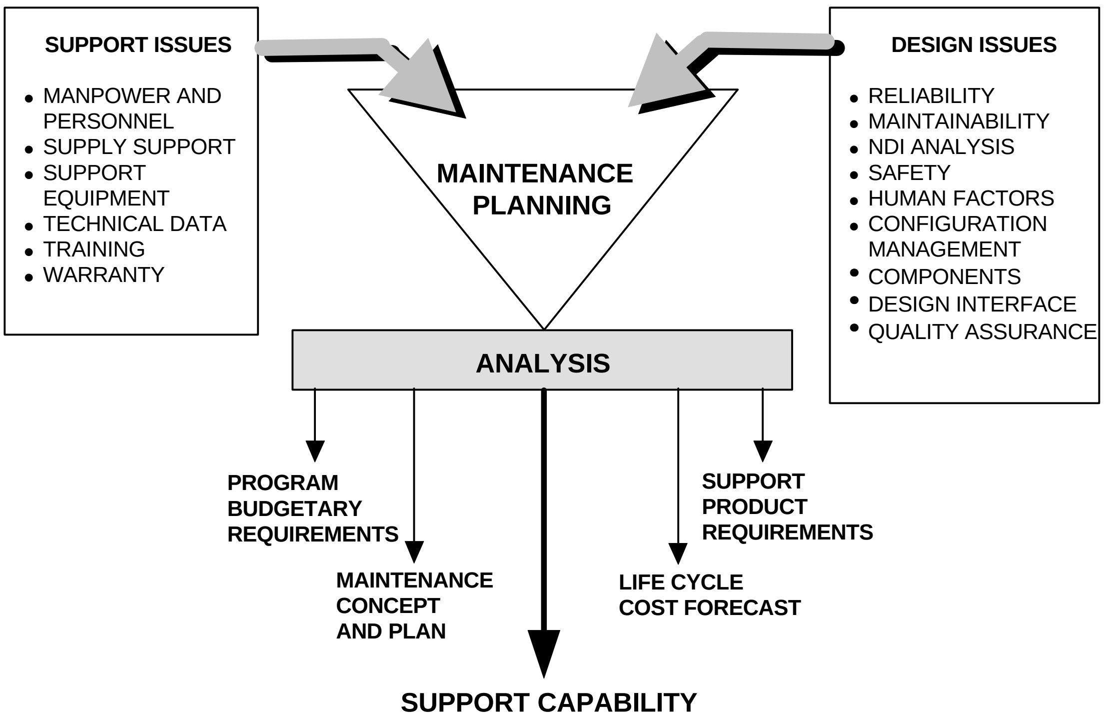

Figure 4-1 Maintenance Planning Overview

The use of open system interface standards and associated market survey (section 5.1) makes information available for use earlier in the maintenance planning process. The market survey information includes:

- products that may be used,
- cost of product(s),
- how the products are supported,
- cost of support,
- availability of product(s) in market place,
- contract mechanisms to allow ordering,
- availability in time frame needed, and
- availability of product(s) for test and evaluation.

This information, along with knowledge of the open system interface standards, provides the supportability team with the ability to conduct effective maintenance planning.

Because information is readily available, the initial maintenance planning evaluation task can include actual *what-if* and *at-what-cost* scenarios. The compressed schedule resulting from the shorter transition from

concept to production phase, places tremendous pressure on the maintenance planning function. Thus the maintenance planner must also become a proactive member of the acquisition team. A summary of open system maintenance planning activities by program phase is provided in table 4-2.

Another important maintenance planning concept is the use of NDI/commercial items that have existing support systems. This allows the leveraging of investments already made; consequently, the use of existing NDI/commercial item support mechanisms is less expensive than developing a new support system. The maintenance planner must also evaluate each OEM's repair and supply support capabilities before making maintenance planning decisions.

PHASE	ACTIVITIES
Phase 0 Concept Exploration	Identify candidate standards. Identify supportability parameters of standards linked technologies. Determine NDI/commercial items implemented and how to support them. Analyze maintenance requirements in all operating environments: • Research and Development (R&D) • Training • In-Service Engineering Agent and Cognizant Field Activity (ISEA/CFA) • Software Support Activity (SSA) • Integration • Installation and checkout • Fleet operational
Phase I Program Definition and Risk Reduction	Refine candidate standards selections. Refine supportability parameters of standards linked technologies. Determine NDI/commercial items implemented and how to support them. Analyze maintenance requirements in all operating environments: • R&D • Training • ISEA/CFA • SSA • Integration • Installation and checkout • Fleet operational Select products. Choose or develop the associated support systems. Consider product and system level Built-in-Test (BIT)/Built-in-Test Equipment (BITE) functions. Consider fault tolerant designs.
Phase II Engineering and Manufacturing Development (E&MD).	Select and integrate products. Develop the associated support systems. Develop product and system level BIT/BITE functions. Implement fault tolerant designs. Plan for upgrade and retrofits.
Phase III Production, Fielding/Deployment, and Operational Support.	Establish fleet support. Plan for upgrade and retrofits. Monitor and coordinate for effective support.

Table 4-2 Open System Maintenance Planning by Program Phase

4.2.1 Hardware Maintenance

No single maintenance concept can apply to all open system interface standards based hardware items. However, the following influences should be examined.

HARDWARE MAINTENANCE PLANNING CONSIDERATIONS
✓ Uniqueness of product. • Is DoD the only user? • On the platform or within the system? ✓ Spares availability from other places within the system or from less important systems at the same user location (platform, locality). ✓ System design provides redundancy or graceful degradation to acceptable performance levels. ✓ A degraded performance level sufficient to meet system and higher level requirements while waiting for supply support action to replace failed parts. ✓ BITE, performance monitoring, and other automated fault detection and reporting capability. • Capability and ability to integrate that capability with other assemblies, both developmental and NDI. ✓ Uniqueness and availability of adequate technical documentation. ✓ Availability of spares an/or repair action from commercial or organic sources. ✓ Availability of adequate technical consultation. ✓ Design stability of the product. • Rate and nature of changes. ✓ Warrantee services.

In general, hardware conforming to open system interface standards will tend to contain large numbers of NDI/commercial items at the replaceable assembly level. If the assembly is NDI/commercial item, repair services are usually available through commercial facilities, negating the need and economic justification for creating organic repair capability. Furthermore, the detailed technical information needed to enable repair of board level NDI/commercial item products is often unavailable to customers. Stockage of board level spares will generally cost far less than the combination of people, training, equipment, and piece parts needed to enable repair of failed assemblies. Also, warranties tend to be voided by non-authorized attempts to troubleshoot or repair failed items.

Built in redundancy or designing for graceful degradation of performance may be used to compensate for slowness of replenishment time for parts which for whatever reason cannot be made available as ready spares. For example, if a computer contains six interchangeable cards of which only four are needed most of the time, graceful degradation of performance to a known level may be acceptable until the replenishment can be accomplished.

The user is generally dependent upon a product support agent like the ISEA, system program office, prime or integration contractor, or a third party activity (e.g., contractor, mobile technical unit (MOTU), etc.) for supply support and processing of failed items into and through the repair process. Planning and implementing this support infrastructure is not a minor task. Providing actual repair capability at the user location may be even more expensive, and less practical.

4.2.1.1 Hardware Diagnostics

Diagnostics may present a challenge. Diagnostic requirements need to be resolved prior to final selection of specific standards. Interoperability of the inherent fault detection and localization capability needs to be established as part of the derived requirements. Information about the inherent capabilities provided by the interfaces specified in the standards and standard profiles, the candidate system architectures, and the specific products being considered is required.. Although good system level BIT and fault localization capability may be achievable with open system interface standards based products, not all implementations may be capable of self

monitoring and error message transmission in a manner which facilitates convenient maintenance actions. Integration of products from different designers may provide acceptable performance, but fault detection, correction, and error message requirements may not be achievable.

4.2.1.2 Hardware Maintenance via Upgrades

Many open system interface standards based products change rapidly in response to market forces and technology developments. In this situation, the maintenance concept may appropriately include support via upgrades. Upgrades which do not affect interfaces (form, fit, and function) may often be easily accommodated. Using currently available items may be more cost effective than executing life-of-type buys or other methods (e.g., repair) by which availability of the original items can be assured. For example, one would not make a life-of-type buy or purchase depot level stock for 30 megabyte hard drives. Larger capacity drives with better access times can be conveniently purchased at lower costs and will fit into the same slots as the 30 megabyte drives while providing the same functionality at higher performance levels. If a failed item is no longer available, then a newer product may have to be used as a replacement item.

Benefits of accomplishing maintenance via upgrades include keeping the system technically up to date throughout its lifetime. Costs associated with this maintenance concept include resources associated with ongoing market survey and test and evaluation (T&E) activities, as well as a need for close coordination between the support agent (e.g., ISEA) and suppliers. Tools to enable use of this concept, such as a parts interchangeability matrix and organizational role changes, are discussed elsewhere in this Guide.

This maintenance concept requires some investments. Many of these investments must be made no matter which maintenance planning concept is used, so their costs cannot reasonably be allocated solely to maintenance. A closely knit support infrastructure must be in place to:

- facilitate technology insertion,
- provide the managerial capability needed to provide a parts interchangeability matrix, training, and technical data,
- ensure that new items, and supporting documentation are conveniently available,
- provide technical expertise to assist in problem resolution, and
- coordinate with other platforms and user systems to enable reuse of retired assets.

This maintenance concept can, and usually should be combined with conventional repair (usually at and by the OEM) and reuse of replaced assets. For platforms scheduled for retirement within five years, maintenance via upgrade is generally inappropriate. Therefore, replacement parts can come from:

- systems being upgraded,
- repair of failed parts, and
- other user systems which have or are being retired or upgraded.

Attention must be given to those items unique to the DoD as opposed to items created and supported for the benefit of other user markets. Uniqueness carries with it a series of economic and practical disadvantages that must be identified and mitigated.

4.2.2 Software Maintenance

The definition of software maintenance differs from that of hardware maintenance by virtue of what the configuration item comprises. That is, hardware configuration items (HWCI) are assemblies of electronic and mechanical components that have different physical characteristics, materials, or dimensions which are documented via drawings and specifications to define HWCI elements and characteristics. In contrast, configuration item/computer software configuration items (CSCI) are a compilation or an assemblage of data streams (bits/characters) in a serial arrangement having no physical attributes other than the medium in which they

are stored. Hence, software maintenance encompasses those actions and processes required for subsequent upgrades and interim fixes/releases to correct, improve, enhance, or add functionality, performance, and efficiency to a given CSCI. Software maintenance encompasses three separate types of maintenance: corrective (correcting software errors), adaptive (modifying software to support a changed environment (hardware/software)), and preventive (implementing enhancement to existing code).

In general software maintenance may be performed by:

- an organic (government) activity,
- non-organic activity (system integrator, or product vendor), or
- both depending on the cost and availability of
  - required data,
  - tools,
  - environment, and
  - skilled personnel.

The availability and quality of data (i.e., source code, design documents, data flow, etc.) determines the amount and type of maintenance control the program office will have on the system.

4.2.2.1 Processes/Activities

Software maintenance processes and activities are driven by the surrounding supporting infrastructure to address:

- problem reporting and corrective action processes,
- software configuration management (CM) with respect to the system CM processes (section 5.5),
- change processes (analysis, development, test, and release), and
- implementation processes (build, delivery, and installation).

How each of these processes/activities is implemented depends on the nature of the software change and who performs the change. For example, changes to commercial software items should only be implemented by the OEM. The OEM specifies the costs and time frame for interim fixes/upgrades. The processes/activities for developmental software are defined by the implementing program. Software trouble reports are developed and corrections funded for subsequent change implementation. Whether the change is directly from the vendor or developed by the government, software maintenance modifications should be fully tested prior to approval for delivery and installation on fielded systems. The government does not necessarily have insight into the quality parameters and process in which the commercial item modification/update was made. The time frame from proposed/planned change to implementation is characteristically quicker than in the past.

Changes that involve modification only to the application program interface (API) (whether commercial item or development) can be effected by the organic support activity providing the supporting technical documentation defining the interface design, support equipment, facilities, and personnel resources are available.

4.2.2.2 Open System Impact on Software Maintenance

The distinguishable characteristic of open systems is that open system interface standards based products support hardware independence. The recognized benefits of open system interface standards based products with respect to software maintenance translate from modularity and commonality of usage into costs savings (in less manpower/personnel, facilities, and support resources) to the government specific to adaptive maintenance. That is, the DoD mandate for commercial software procurements has caused a shift from full system product development as well as lessened proprietorship among OEMs to participation in the ‘plug and play’ environment. As a result, this shift in product development has promoted adaptability among products in areas of modifiability, expandability, portability, flexibility, and interoperability. This product adaptability in turn supports: greater data

format transparency and access among heterogeneous platforms translating into less cost and less risk to government while promoting faster technology insertion into the fleet.

SOFTWARE MAINTENANCE PLANNING CONSIDERATIONS
✓ Uniqueness of product. • Is DoD the only user? • On the platform or within the system? ✓ Uniqueness, availability, usefulness of software related technical documentation. ✓ Availability of technical consultation. ✓ Design stability of the product. • Rate, and nature of changes. ✓ Software upgrades (i.e., cost, tracking changes, anti-virus and tampering features, data availability). ✓ Software license factors and degree of coverage. ✓ Length of product support. ✓ Escrow account agreements, especially the cost effectiveness of buying the feature. ✓ Software support factors including cost-effectiveness trade-off studies. ✓ BIT/BITE capabilities. ✓ CM factors (i.e., change periodicity being experienced, product tracking capabilities, product line similarity, source code availability, standards profile to product information, conformance testing data, etc.). ✓ User data/track record/reliability factors. ✓ Warrantee service.

4.2.2.3 Approaches/Guidelines

The software OSE must be defined. This can be accomplished by specifying requirements that support open system interface standards based products and the use of commercial software to support system requirements. Software maintenance planning should be focused on standard APIs. Specifying software support metrics early can greatly reduce the required software maintenance costs later. Two thirds[17] of software life cycle costs are expended on maintenance support.

In the case of commercial items, the government will be dependent on a vendor for software maintenance via a warranty or service contract. This normally suffices to meet supportability and software applicability concerns. Alternatively, the program office may sometimes be able to purchase data and data rights, and fund development and maintenance of a SSA to perform the same role. Quite often, vendors are not willing to sell their data rights; therefore, the government should be concerned that the software development firm may go out of business. One method to reduce risk is to establish an escrow account, whereby a third party holds custody of the source code and supporting technical data required.

[17] Chapter 7: Post Deployment Software Support, Mission Critical Computer Resources Management Guide (US Government Printing Office, Washington, DC, undated), 7-3.

The following SOW wording is provided for escrow account establishment:

<u>Escrow account for system code</u>. The contractor shall place two copies of the source code (on magnetic media, formatted to be read and compiled on contract equipment as part of this contract) in an escrow account under the custody of a third party mutually agreeable to the government and the contractor. Each copy of source code shall be kept current by the contractor for the life of the contract. The agreement with the custodian shall include a binding provision for immediate release of all source code to a designated government representative upon receipt of a request from the Contracting Officer which states that software support under this contract has failed to meet the terms and conditions specified.

In the event that more than one baseline is being maintained (that is, for the purpose of upgrading the system software) that source code shall also follow the escrow procedures stated in the above paragraph.

If the software product is developed for a specific DoD program, some benefits of open system interface standards (e.g., Portable Operating System Interface (POSIX)) may still be obtainable. These benefits come from the stability of APIs across generations of operating system and application software programs. Benefits attributable to stable APIs are:

- reduced quantity of new source lines of code (SLOC) needed, and
- more legacy software product(s) will be reusable (e.g., application data and application software).

4.2.2.3.1 Software Maintenance Example

As a means to demonstrate the ease of software maintenance through the use of open system interface standards, this example (table 4-3) discusses the reusability of standard APIs from one generation of application software to the next. In our example:

- The host hardware and operating system are changed concurrently.
- The application program is changed to provide:
  - the same, similar, or somewhat improved functionality, and
  - the same, similar, or somewhat improved performance.
- 48 of the 60 APIs are the same for the old and new software.
- Only 12 of the 60 APIs are no longer used.
- Used 17 new standard APIs for:
  - performance enhancement,
  - streamlining code, and
  - improved technology.

ORIGINAL	REUSED	NEW
Application software program	36 software modules	Replaced 5 software modules
60 standard APIs	48 standard APIs	17 standard APIs
Operating system		Moved to current release
Hardware: chassis and 7 lowest replaceable units (LRUs)	Hardware: chassis and 6 LRUs	Replaced obsolete LRU

Table 4-3 Example Of Software Upgrade Transition With Relationship To APIs

Compared to a traditional scenario, in which the operating system was part of the application software, or existed as a proprietary (single user) “executive” program, this update scenario takes less time and costs less money. Some of the reasons this is true are:

- The operating system(s) may be a commercial product which complies with open system interface standards:
  - There is a pool of users.
  - The costs and time associated with development, testing, and support are spread across the pool of users.
- Software maintenance costs are not the same for each and every SLOC.
  - The costs could be dependent on the type of change.
  - The change could impact other computer resources.
- Complexity, time, and cost of changing the application software may be dramatically reduced because most of the interfaces to the operating system may:
  - contain many of what would otherwise be application program functions,
  - remain the same from one generation of operating system and application program software to the next, and
  - preserve usability of the software modules (products) which implement these functions.
- Eighty percent (48/60) of the APIs in this example continued to be used from one generation of application software to the next.
- This stability of interfaces implies that most software modules of the application program can remain constant, i.e., there is no need to develop new code.
- The old code can be recompiled to the new host hardware, essentially reused, saving code development and test costs, especially for mission critical systems.

4.2.2.4 Related Costs

In the past the cost of software maintenance has consumed more than two thirds (2/3) of the software life cycle costs. However, and as noted earlier, software maintenance costs can be minimized with an open systems approach through the use of standard APIs (stability) to effect adaptive changes. Stability of APIs translates to less risk in development, modification, testing, schedule, performance, and overall software maintenance costs. Most of the APIs offered by commercial applications support openness (primarily to ensure vendor preservation in the marketplace).

Some software maintenance costs to consider include:

- Make (or modify) vs. buy costs (that is, perform a make vs. buy estimate to assess/analyze the buy costs of the software modification suggested).
- Rehosting existing code (e.g., gray box computer language (i.e., CMS2) supporting legacy systems vice new development to emulate existing functionality).
- SLOC required to affect the modification and its impact on memory reserves, processing speed, response time(s), etc. which may translate into costs beyond that of SLOC modifications.
- SLOC complexity.
- Application code updates resulting from periodic updates to commercial software.

Even if all or part of the software program is produced and maintained by an outside supplier, the costs will still be present. Commonality among multiple customers of the open system interface standard software allows the supplier to divide the cost of making changes among more customers, thus lowering the effective cost to each customer.

Figure 5-1, Product Survey Form, may serve as a basis (or starting point) for comparison of alternatives and budget and program plan development. Although the form was developed for NDI/commercial items market

surveys and acquisition planning, the charted cost accounts can serve as prompts for developmental planning and as a means to estimate costs of a proposed software change

4.3 Manpower and Personnel

As the technologies of communications and computers become more common and open, there is a decrease in the number of different information sources needed for support of a variety of systems that use these technologies. Open systems promote commonality among products, whether they be hardware, operating systems, or applications. This implies: reduced number of Navy Enlisted Codes (NEC), reduced number of operations and maintenance personnel, and portability of personnel across the different hardware/software boundaries.

Proprietary systems suggest uniqueness, which in turn brings the need to retain uniquely qualified support personnel. The commonality of the open system interface standards based products (e.g., POSIX-based operating systems) eases development of new software and changes to old software by the SSA, reducing the number of personnel at the ISEA/CFA and the SSA.

Use of open system interface standard based products in the fleet reduces the number of *unique* NECs for systems deployed. A decreased number of unique NECs generalizes the training requirements and develops personnel who have a broader knowledge base. For example, tactical computers (TAC) are used across many system domains resulting in a common knowledge base (NEC type) across these systems. The information affords the opportunity for fewer people to be able to maintain and operate more different systems. Depending on actual workload, this will tend to bring about an opportunity to decrease the total number of personnel required at the platform level. A manpower requirements analysis must be conducted to optimize the mix of personnel and skills.

Technology can provide ways to increase efficiency. A move to open systems will enhance this by creating a personnel portability as systems may be designed in such a way that personnel can transfer their training and experience from one system to another.

MANPOWER AND PERSONNEL PLANNING CONSIDERATIONS
✓ Determination of maintainer proficiency levels versus the projected technology and product insertion.
✓ Identification of number and type of operator and maintainer levels to meet requirements.
✓ Identification of deltas between legacy and “to be” architecture needs.
✓ Determine if existing skill levels are ample to meet new and existing requirements.
✓ Degree of difficulty of personnel training to operate and maintain the end-item.
✓ Product/system capability to provide self test and training services.
✓ Similarity of technology with current platform systems, products, and services.
✓ User maintenance instructions.
✓ Operator instructions.

4.4 Supply Support

Supply support[18] within the Services has traditionally been stated as :

- Availability of organizational, intermediate, and depot level repair parts, insurance spares, and replenishment parts, in the supply system to replace the above as they are used.
- Supply support includes technical documentation that provides the maintenance philosophy for the end item equipment and identifies the parts required to support the maintenance philosophy.

Just as in past DoD acquisitions, open system acquisition supply support also needs to provide the spare and repair parts necessary to operate and maintain the end item at defined levels of maintenance that meets specified

[18] SPAWAR P4000.14, SPAWAR Desk Guide for Supply Support Planning and Execution.

operational availability requirement usually defined in the ORD and other acquisition documentation. Current DoD policy[19] requires that support concepts for new or modified acquisitions maximize contractor long-term logistics support that combines depot-level maintenance and wholesale and selected retail materiel management functions while still maintaining limited organic core depot maintenance capability to meet essential DoD defense requirements. Life cycle costs and associated risk factors are key selection criteria's.

In most new or modified acquisitions, systems will move from existing, legacy and proprietary environments toward an open environment. The planning for supply support must therefore include both legacy and open systems. The shift to an open system environment provides an opportunity for more rapid technology insertion and upgrade. Upgrade can proceed on a constant basis. Technology upgrade and supply support functions become intermingled. As more open system interface standard compliant products become available, initial acquisition costs may be reduced. Since the products are not necessarily interchangeable, supporting a particular baseline with functionally equivalent products from multiple sources incurs risk. The Navy should retain the right to procure directly from the OEM (rather than the system prime or integration contractor) to obtain the best value.

Commercial support systems (repair, technical support, etc.) that exist for vendor products that meet standards applications should be utilized whenever possible rather than developing a redundant capability. Typical support that can be leveraged includes support to:

- R&D facilities (usually consisting of technical consultation and documentation of interface compliance and features),
- integration and test facilities (usually including user-oriented technical documentation as well as repair support and technical manuals close to those which will support field usage),
- user location (field) installation and test activities (same as integration facilities but with more and different spare parts and technical support), and
- long-term operational environments (i.e., fleet ships, aircraft, etc.).

Product choice and usage decisions must consider the availability, completeness, and quality of support to all these environments.

The various OSA standards themselves, combined with vendor support of products that implement them, will create a stable board, box, and system level development environment that will routinely outpace the DoD unique product environment by up to 50%. This estimate is based on actual industry planning and experience in an OSA environment. The impacts of this are manifold:

- Product support will be required much sooner than in past experience. We must be ready to contract for support and training of our infrastructure such as our Warfare Center personnel, if they are to be involved in oversight of product development or fleet users support.
- Product support will depend on a variety of usage environments and needs. DoD operational system environments are but a small and perhaps insignificant part.
- We must plan how to live with a product before committing to using it in our systems.
- Program planning and budgeting must reflect these new realities.

In most cases, commercial replenishment of spares can be anticipated for products already used and supported in commercial environments. The mechanics for routine processing of requisitions on the commercial market through DoD Inventory Control Points (ICP) already exist. By using electronic data interchange (EDI), a user should save time and money.

4.4.1 Supply Support Planning

[19] DoD 5000.2-R, 15 March 1995, Part 3, page 14.

As systems and products become more technologically advanced and complex, the need for planning is even greater. The need to plan earlier is critical in an open system environment. Choice of initial standards and products influences the ability to support the product in the future, and hence useful life. The costs of system support are largely influenced by decisions made in the early phases of the life cycle. Supply support planning and sparing must support the maintenance decisions. In an open system environment the need to achieve the required A_o is still present. Performance must be maintained.

The supply support process, as it applies to an open systems acquisition effort, must be capable of reacting to rapid or frequent changes in demand, vendor access or availability, cost factors of selected end items, technology enhancements, engineering judgments resulting from analyses or reliability data collected over time, and other factors such as the end of all production. Support concepts vary from program to program. For example, in one case failed end items or LRU's are sent to an established deport for analysis, repair, or modification until design or support decisions are stabilized. In another case the support concept might be to lease support from either the prime integrator for a period of time to establish useful reliability and support data. The key is that when dealing with an open systems end item, unique supply support issues may influence the decisions on how to provide and manage the support to the end item user.

Provided below are some supply support considerations that should be planned as part of an open system acquisition.

SUPPLY SUPPORT PLANNING CONSIDERATIONS
✓ Identification of maintenance echelons required to meet user needs. ✓ Support environment (weather, shelter/non-shelter, etc.) considerations. ✓ Warranty procedures and cost effectiveness over life cycle of end-item. ✓ Organic support depot cost-effectiveness. ✓ Commercial depot support capabilities. • On-site capabilities. • Turn-around times. • Lead time. ✓ Single point service restrictions of end-item. ✓ Spare part lead times. ✓ Availability of tools, test equipment, computer support resources, calibration, technical manuals (etc.). ✓ Manufacturers commitment for out-year parts support. ✓ Repair parts availability and support production line continuance. ✓ On-board spare requirements. ✓ Availability of depot level support and spares vs. Reliability and cost-effectiveness issues. ✓ Determination of end item replacement concept (repair or discard item). ✓ Determination if historical data of end item correlates directly with item being considered for integration or sparring. ✓ Cost-effectiveness of establishing manufacture support for end item(s) versus Service depot support. ✓ Joint programs/products supply support factors for similar or identical end item(s). ✓ Navy Inventory Control Point (NAVICP) support of the same end item and established length of the support in place.

4.4.2 Selecting Sources

Open systems provide new dimensions to supply support that are not always apparent in a proprietary system. Open systems allow optimal product choices to be made, based on interface and performance attributes from a wider range of sources. This freedom of choice is not without risks. Assuming the products are equal (interchangeable) in form, fit, and function, a choice must be made in both product and product source.

Most implementations will involve a combination of legacy or proprietary systems along with open system interface standards based products. The market survey[20] should be used as a basis for identifying candidate products and sources. In selecting open system interface standard based products the user must be concerned with the OEM's experience with proprietary systems and open systems, both hardware and software. This information forms the basis for solutions to integrating the old with the new. No matter the source or product selected, it will have to be qualified for use in the existing system.

Interface commonality allows the use of different, yet interchangeable, replacement items (i.e., sparing with a new product rather than a new copy of the old product). The supply support team must be familiar with appropriate interface documents to identify candidate items for sparing. The goal is to have interchangeable spares alternatives that meet performance and interface requirements, or have a work-around in place to avoid performance degradation.

In obsolete product cases where interchangeable products are not available, functionally equivalent products shorten the product replacement time. For example, the functions are the same, but the partitioning is different. This will require some software changes to enable use of the new product.

Some processes can make the change easier to handle. One is the parts interchangeability matrix (PIM), used to document applicability of new and old items to furnish support of product baselines being supported. The PIM (section 5.5.9, table 5-1) documents which parts can be used with each other. It covers the interchangeability of hardware and software elements (generations of the part or part family) across the different system and unit level baselines.

Another process is reutilization of replaced system assets, including upgraded platforms. Basically, the process consists of reusing hardware that has been replaced by more current baselines to support platforms that have not yet been upgraded. A process already in use but receiving little publicity, is reuse of residual assets from decommissioned ships and aircraft.

4.4.3 Supply Support Data

The requirements for provisioning technical documentation (PTD) have significantly changed. The minimum amount of PTD required for commercial item is price, part number, and reliability data (preferred but not necessarily required). In this situation the government develops the additional provisioning data. In addition to the greatly increased ability to handle and exchange data inherent with today's computerized business systems, the use of open systems based commercial item often eliminates the need for traditional PTD delivery. The rapidly moving commercial base implies shorter life cycles for product availability. The rate of change inherent in commercial products affects how frequently new PTD data is generated. Product obsolescence occurs sooner, resulting in a life cycle problem for buying spares and support. When the costs associated with procurement of PTD are deemed excessive, then provisioning alternatives should be sought. If the integration contractor can not provide PTD, the ISEA/CFA and/or support contractor may be a good choice to do so.

For handling supply support and PTD, the NAVICP, in conjunction with Navy Supply Systems Command (NAVSUP), has developed an innovative method referred to as "just in time" supply support. This method uses the commercial support infrastructure instead of the military supply support system. The integrator or OEM provides user manual type information and also develops the allowance parts list (APL) using only selected data elements. The APL is available at a fraction of the time and cost of traditional PTD methods. This APL appears the same to the fleet user and allows him to identify and requisition material using standard military requisitioning and issue procedures (MILSTRIP). However, once the MILSTRIP requisition is submitted, the inventory control point uses electronic purchase orders transmitted directly to the vendor in commercially developed and recognized formats. The vendor then ships the spare part from the commercial warehouse directly to the end user. The government is thereby saved the direct cost of storage, as well as the distinct risk of stocking obsolete spare parts.

[20] The market survey is discussed in section 5.2.

4.4.4 Testing of New or Replacement Spares

Assurances are needed that the products and supporting spare parts procured are compatible and interchangeable with existing systems. For most procurements, it is not enough for manufacturers to state that their products are compliant with the required standards. Program offices may want to perform independent verification of the claimed conformance as a matter of course. Independent testing of candidate products may be required to ensure compatibility with existing systems. Two issues must be considered:

- Does the product conform to the stated interface standard or profile? If the unit or system conforms, then it is important to keep that conformance. Otherwise, future upgrades or failure induced replacement efforts may be jeopardized.

- Is the new item really interoperable with the host unit or system? Factors other than the interface standard, such as processor type and speed, may enhance or detract from host unit or system performance, or make the new item unable to interoperate successfully. Risk mitigation is obtainable through testing of all candidate items.

Conformance testing is the process of verifying that an implementation performs in accordance with a particular standard, thus minimizing risk. Independent conformance and interoperability testing should be performed prior to the procurement of any spares. Consequently, potential conflicts with legacy systems are evaluated and made known prior to final procurement decisions.

One of the problems with standards is that in addition to the minimum (core) requirements needed for compliance, standards contain many optional features that manufacturers may choose to implement. The optional features include:

- alternative ways of implementing a feature,
- features which are not mandatory, and
- ranges for values of variables.

The selection and interpretation of optional features, as well as extensions to the standards, is critical to the interoperability and compatibility of existing systems with new systems. Unless the product developer has been given strict guidance as to allowable or disallowable optional features, program offices will need to be concerned with the implementation of options in open system interface standards.

Independent testing of candidate products may be required to ensure compatibility with existing legacy systems. This is especially true for the procurement of spares. Spares procured concurrently with the production item and from the same source as the production item, are likely to:

- have identical configurations,
- be interchangeable, and
- be tested in the exact same manner as the production item to verify interchangeability.

Spares procured from a source other than from the original manufacturer or procured from the same producer but later in the products life cycle should be tested to ensure interchangeability and compatibility. Changes in the product resulting from upgrades may result in a loss of interoperabitlity or reduced functionality when used in a fielded system(s).

To properly compare two systems, they must be subjected to the same tests. One way of determining the likelihood of two systems interworking (being interoperable) with one another, is to subject both systems to “live” testing in the planned system configuration.

As open system interface standards are developed, conformance testing must also be developed.

The program office must be prepared to understand the test results. A test suite for a given protocol is going to contain a number of discrete tests. For each test, there will be an outcome to which a test verdict will be assigned (pass, fail, or inconclusive). The program office will need to define the pass/fail criteria. Clearly, the requirements need to be precise and unambiguous to minimize risk.

As more and more suppliers and developers base their product lines on open system interface standards, sources for standards-compliant products will increase. As the number of sources increases, several things will happen. The marketplace will drive out or minimize the uniqueness of standards implementations, or there will be more uniqueness in order to capture a certain niche in the marketplace. In either case, the risk of non-interchangeability and non-compatibility still prevails. *Caveat emptor*, i.e., let the buyer beware.

4.5 Support Equipment

Commercial open system interface standards are developed with a consideration on how conforming products will be maintained in commercial markets. Support equipment suitability and costs are primarily affected by technology insertion and rate of product changes.

Currently, fielded systems have been designed to use test equipment normally found on naval platforms and at shore sites. Support equipment usually requires some form of calibration to ensure it’s functionality. The rapidly expanding use of commercial items that are not driven by either current support equipment directives or policies requires evaluation of proposed commercial items (hardware or software) support equipment requirements. Provided below are typical planning considerations for identifying and providing the necessary support equipment to the end user.

SUPPORT EQUIPMENT PLANNING CONSIDERATIONS
✓ BIT/BITE capability integrated into end item. ✓ BIT/BITE effectiveness to isolate failures. ✓ Need for special test equipment vs. usability of current on-hand test equipment. ✓ Unique support and test equipment necessary and cost-effective. ✓ Need and cost effectiveness of related test program set (TPS) products for the end item. ✓ Calibration standards requirements/necessities. ✓ BIT/BITE integration factors (physical and software related) and costs. ✓ BIT/BITE contractual factors. ✓ Support equipment operator and maintenance training requirements and costs. ✓ Does the rate of product change affect TPSs. ✓ Unique support equipment use on other pending systems/equipment’s (sharing of costs).

Commonality gained through increased use of open system interface standards can reduce the total number and different types of test equipment required resulting in reduced total costs. Corresponding test equipment support costs can also be reduced. When development of hardware support equipment is needed, it can be accomplished using open system interface standards. When TPSs are necessary to meet system support requirements, the change rate of products directly affects how often TPSs will need to be changed.

Depot level support equipment requirements will be determined on a case-by-case basis. The manufacturers of compliant products test them during production. These same tests can be used during the repair process by the OEM. There may be no need for Navy investment in depot level support and test equipment. However, these OEM capabilities may be insufficient in some cases to meet system support requirements. Those cases require a traditional organic depot or life-of-type buy.

The number of unique support equipment can be reduced or eliminated when LRU and system level BIT is capable of isolating failures to a single or small group of LRUs. System level BIT must be considered, when

integrating a system, in the partitioning of the system functions and integrated across all functions of the system. Many open system interface standards provide requirements for BIT and panel indicators that visually identify the failed LRU. Sufficient BIT capability can mitigate the need for support equipment suites. For example, system level BIT on a multi-unit system can be implemented by connecting alternate access ports (serial) on each unit to a common BIT processor that runs system level performance monitoring and diagnostics. BIT capability is easier to obtain because of functional partitioning characteristics inherent to open system interface standards usage.

The OEM has developed production line testing that can also be used to repair a failed LRU. When LRU level BIT or system level BIT is used, the number of unique TPSs can be reduced by returning failed items to the OEM for repair. This results in leveraging the OEMs' development of production and acceptance test capabilities instead of developing TPSs.

4.6 Technical Data

Traditionally, technical data began with the system specification and proceeded forward. In an open system interface standards based acquisition, configuration management of program technical documentation and system architecture needs to start during concept evaluation. The architectural framework, baseline characterization, and target architecture documents along with data required for supportability are all necessary technical data. All contracts are required by DoD 5000.2-R to require on-line access to, or delivery of, their programmatic and technical data in digital form. A further requirement is for preferences to be given to on-line access to contractor developed data through contractor information services rather than data delivery. The ability to rapidly accrue, compare, and dispense technical data accurately can mitigate risks, schedules, and cost factors.

The use of open system interface standards relates to technical data in two basic ways:

- Provides a definition of certain interfaces in a system.
- Contributes to the increased use of NDI/commercial item hardware and software products to meet system requirements.

Open system interface standards can be viewed as technical data describing significant aspects of system and product design. The open system interface standards, in conjunction with the selected profiles, fully define the interface requirements for a product. The standards and standard profiles are stable entities while the product profile can change. Thus, it is important to document the product profile for future reference (e.g. spares procurement). Open system interface standards are available through the organizations (e.g., Institute of Electrical and Electronics Engineers (IEEE) and American National Standards Institute (ANSI)) which sponsor development, manage configurations, and control updates. Because open system interface standards, standard profiles, and the product profile(s) define the interface implementations, the only other data that may be required to fully document the interface configuration of a system using NDI/commercial items is the commercial performance data sheets which are generally widely available at no cost.

Other technical data issues arise from open system interface standards contributing to the use of NDI/commercial items in implementation of a systems architecture. These include:

- data rights versus data ownership,
- adequacy of drawings,
- adequacy of technical manuals,
- modifications to hardware or software, and
- support after obsolescence.

The adequacy of the technical data for NDI/commercial items should always be examined. The use of NDI/commercial items provides an environment in which technical data may be inexpensive and accessible; however, the data may or may not be adequate. Technical manuals, user's manuals, drawings, and training materials will all need to be examined for adequacy prior to contract and procurement. Data adequacy may need to become a source selection criteria. If a product with inadequate technical data is to be selected, licensing arrangements will need to be pursued to procure the

required data either from the OEM or another source. Normally, the government requires less data on NDI/commercial item products than on developmental products so acquire only the data that will actually be needed. For hardware, lifetime buys of spares can mitigate some technical data requirements. Another possibility might be a license to use the OEMs drawings if the OEM goes out of business. For software, a restricted use license for use of obsolete source code may be arranged.

Many commercial standards represent the least common agreed upon set of functionality. This implies that functionality (extensions) must be added to ensure a “sensible” implementation results. Beyond the standard, the technical data must also include documentation of all such extensions and modifications to the given standard. This includes vendor provided operating manuals.

Accurate documentation of a cabling system is important and should be readily available. Technical resources include installation guides for all network hardware and software components. They sometimes lack the technical details of network operation, however. For that reason, it may be useful to obtain technical specifications. Every network interface card contains controller chips that implement the access protocol; the manufacturers of these protocol handler integrated circuits can provide useful hardware specifics. Software developers also provide technical documentation on their protocols.

TECHNICAL DATA PLANNING CONSIDERATIONS

- ✓ What baseline documentation is available?
  - Drawing materials (i.e., level 2 or 3 drawings, computer-aided design/computer-aided manufacturing (CAD/CAM) data.
  - Software data (i.e., software requirements specifications, source data/listings, etc.).
  - Historical data of end item (reliability predictions/reports, trouble reports, engineering change proposals (ECP)/specification change notices (SCN), software database, etc.).
  - Design analysis data (i.e., finite element analysis (FEA), boundary element analysis (BEA), solid modeling, interface modeling and simulation).
- ✓ Is an interface standard(s) profile conformance management policy in place?
  - Projected or selected profile(s) promulgated.
  - IPT/program managers familiar with profile(s) use and optimization.
  - Tracking mechanism in place for non-conformance.
  - Tracking of emerging standards/profiles and associated training.
  - Conformance test process/verification in place.
- ✓ Is a method for verifying conformance in place?
  - Labs capable of validating product lists/claims/performance.
  - Alternative testing available.
  - Assessments of available test data.
  - Demonstrations (i.e., portability, interoperability, and vendor independence demonstrations).
- ✓ What are the technical data exchange capabilities, (i.e., access of various support data via electronic/digital form, section 4.6.2 and tables 4-4 and 4-5) between the government (including NAVICP), prime contractor(s), subcontractors, vendors, and suppliers?

4.6.1 Technical Data Rights

The Defense Federal Acquisition Regulation (DFAR) data rights supplement (29 September 1995) further defines data rights protection for vendors. The DFAR prohibits the government from requiring vendors to supply any technical information about a commercial product that is not generally provided to the public. The government has unlimited rights to technology that is developed exclusively with government funds or is otherwise available without license restrictions, including the right to disclose it to other parties. The government has rights to use technology developed jointly, with federal and private funds, for "government purposes" only for a specified period. After this vendor protection period expires, the government could use the technology as it sees fit, including making it available for commercial use. The government has restricted rights to technology developed at private expense, based solely on the

licensing agreement negotiated with the vendor. In all cases, subcontractors will be entitled to the same protection as prime contractors under the regulations.

4.6.2 Technical Data Exchange

The program office needs access to databases within DoD and industry to conduct an adequate market survey upon which to base tradeoffs. Market survey data (e.g., product descriptions and open interface standards and tutorials) can constitute the initial technical data. There are also many public pathways to technical data which facilitates ongoing market survey and program communication. The Internet provides a virtually free network of world wide web (WWW) home pages, many of which contain technical information provided by developers and producers of high tech electronic products. Standards bodies have home pages too, as do many computer magazines and trade associations. A wealth of technical information, as well as points-of-contact, can be obtained.

The program office can initiate and implement mechanisms to facilitate access to and transfer of programmatic and technical data. Technical data that needs to be exchanged includes:

- program management,
- engineering,
- reliability, maintainability, and availability,
- design,
- prototype development,
- manufacturing
- CAD/CAM,
- test,
- quality assurance,
- configuration management,
- technical manuals (standard and/or interactive electronic)
- training support,
- installation control drawings and installation drawings,
- manufacturing/production schedules,
- parts data from many sources, and
- direct insight of product changes and market trends.

Many commercial manufacturers are implementing their own technical data continuous acquisition and life support (CALS) oriented architecture, often using products that comply with the Joint continuous acquisition and life support (JCALS) standards, infrastructure, and APIs. Some of the support which the open system interface standards based JCALS structure can provide to the program office are shown in table 4-4. Table 4-5 describes applicable CALS standards which ensure open digital data exchange capabilities.

FEATURES	BENEFITS
UNIX/POSIX Based.	Promotes portability of applications.
X-Windows/MOTIF GUI.	Provides consistent look and feel; user friendly.
Supports Transmission Control Protocol/Internet Protocol (TCP/IP) and General Open System Interconnection Protocol (GOSIP).	Enables connectivity to most Local and Wide Area Network (LAN/WAN) environments.
Support for personnel computers, X-Terminals.	Protects governments capital investment.
UNIX workstations, MACINTOSHs, and communication environments NDI/commercial item independence.	Eases technology insertion; not dependent on specific vendors; scaleable; expandable; protects investment in software; reduces development costs.
Supports CALS industry standards.	Supports government/industry digital interoperability; eases migration.

Table 4-4 JCALS Open System Environment

DoD	INDUSTRY	APPLICATION
MIL-STD-1840		Automated interchange of technical information
MIL-D-28000	IGES (ANSI Y14.26M)	Vector graphics; CAD/CAM
MIL-M-28001	SGML (ISO 8879)	Text; Documents
MIL-R-28002	CCITT GR4 (ISO 8613)	Raster graphics; Scanned images
MIL-D-28003	CGM (ISO 8623)	2-D vector graphics (technical illustrations)
MIL-STD-1388-2		Logistic Support Analysis Record
	PDES/STEP (ISO 10303)	Product Description
	EC/EDI (ANSI X.12/X.400)	Electronic exchange of business information
ACRONYMS		
CCITT - International Telegraph & Telephone Consultative Committee group 4 (ISO 8613)		
CGM - Computer Graphics Metafile (ISO 8623)	EC/EDI - Electronic Commerce, Electronic Data Interchange (ANSI X.12/X.400)	
IGES - Initial Graphics Exchange Specification (ANSI Y14.26M)	PDES - Product Data Exchange using STEP	
SGML - Standard Generalized Mark-up Language (ISO 8879)	STEP - Standard for the Exchange of Product Model Data (ISO 10303)	

Table 4-5 Digital Data Exchange Capabilities

4.7 Training and Training Support

Training and training support can be achieved more efficiently using open system design approaches. Using open system approaches in conjunction with commercial support and rapid upgrades requires that the training program be reviewed more often and more thoroughly to ensure that it is current with the advancing technology. As open system interface standards usage increases, the number of different interface types decreases, thereby reducing the required number of NECs. When this is applicable across various systems and platforms, it provides the program office an opportunity to leverage the existing NECs and their training programs for support of a new system. The use of NDI provides an additional opportunity for the program office to leverage existing training programs.

CM of the training courses and materials can be a serious challenge in an open system environment. The rate of change in the products being supported requires planning for a larger than traditional CM role for training courses and materials. CM is discussed elsewhere in this Guide.

The full range of training needs includes the developing organizations (i.e., program office/warfare center acquisition team), fleet operators and maintainers, the in-service engineering activity, training instructors, the SSA, and maintenance personnel.

TRAINING AND TRAINING SUPPORT PLANNING CONSIDERATIONS

- ✓ Is the OSE related technology addressed within the training curriculum?
- ✓ Can the training be incorporated into an already established NEC?
- ✓ Is computer-based training feasible for meeting the system training requirements?
- ✓ Can the system provide OJT as part of on-line system interaction with the operator and maintainer?
- ✓ Is a training plan in place to provide OSE and technology training requirements for the program?
    - Has the need to update training with product changes been addressed?
    - Have sufficient support product(s) and spares been addressed for training?
- ✓ Can commercial training meet program requirements? Is it available and cost-effective?
- ✓ Is the system's OSE training requirements a key part of the IPT design and support considerations ?
- ✓ Have all levels of support been addressed as part of the training plan/effort?

4.7.1 Program Office/Warfare Center Training

T he program office and warfare center personnel can obtain overall open system knowledge in several ways. One recommendation is to attend the Open Systems Joint Task Force (OSJTF) supported open systems training seminars being made available at both the executive and program office level. The OSJTF course is available for presentation to an entire program office team (engineers, acquisition planning, and product support personnel) and is regularly scheduled or arrangements can be made to present it locally.

The Naval Postgraduate School (NPS) offers several curricula including Information Technology Management and Joint C3I curriculum in its Masters program. Both curricula teach open systems and introduce students to standards in several technology areas. In addition to the resident program, the NPS can provide several formats of outreach including resident short courses, seminars, distant learning, and on-site short courses.[21]

The training costs of the SSA must be considered. Using interface standards and languages common to the commercial sector enhances the availability of commercial courses. One challenge is to provide training that keeps up with ongoing changes in commercially based products, such as operating and data base management systems.

These sources of training are a useful prelude to embarking upon usage of open system interface standards in DoD systems. In addition, training on specific open system interface standards is available through standards organizations and commercial training firms.

4.7.2 Fleet Training

To take full advantage of open systems and NDI product usage and support opportunities, we have to overcome our cultural bias toward fully organic product support. Availability of commercially based open standards and the products that implement them gives us the opportunity to examine existing training, determine probable costs, and perhaps test existing training products and services prior to large scale expenditures

As an alternative to pipeline training, we may take advantage of commercial training classes. Many of the classes used by commercial firms to train their own employees and dealers can, in whole or in part, be used for training. This is particularly applicable for applications where the total number of people to be trained is small, or when the need for training is infrequent. We would need the ability to contract for the training on a timely basis. We can pay the supplier to come to us or send the students to the commercial or other government training location.

Fleet personnel training locations may be shifted by a combination of open system usage and other technology-based trends. The commonality of technology application across formerly disparate systems, have resulted in a reduction of the number of NECs e.g., sonar, radar, communications, command and control. With fewer NECs to train, the number of unique training courses required to support each system can be reduced. Likewise fewer instructors will be required to support training needs. In the sense that this enables fewer people to maintain larger numbers of products and systems, this is beneficial. In terms of the capabilities now expected of maintenance people, it is a major challenge. One way to meet this challenge is to use electronically based training, provided at the work location, e.g., ship, rather than in formal pipeline training sessions. Modeling and simulation are also tools suitable for training maintainers as well as operators.

As open standards defined self diagnostic capabilities are implemented, a relative decrease in the required skills of maintenance personnel can be expected This in turn shall reduce fleet maintenance training requirements.

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[21] Refer to Internet url http://www.nps.navy.mil for additional information.

4.7.3 Intermediate and Depot Training

The training expense associated with intermediate and depot level repair will, in most open system interface standard product cases, become part of the costs associated with commercial repair of the item. From an economic view, commercial training usually provides a higher quality of training, lower training personnel turnover, and modern, well-maintained equipment. All these can reduce cost per repair. For various reasons, most of these training factors are difficult to maintain in DoD depot and intermediate repair facilities. Centralization, spreading of fixed costs across as many users as possible, and elimination of costs are all routine commercial economic goals. Each of these reduces costs to the end user, be that DoD or some other customer.

In those cases where organic depot or intermediate repair is deemed necessary, training costs may still be reducible through usage of commercial training of DoD maintenance personnel by the OEM. Obviously, this situation is best addressed during the market survey and proposal development phase of the program office activity.

4.7.4 Examples and Rationale

Consider training in two scenarios: use of NDI/commercial items and use of DoD unique products developed in accordance with open system interface standards.

In a commercial item(or other NDI) usage scenario, product and associated training have already been developed or are under development. Hence there is opportunity to review, evaluate, and perhaps make use of all or part of existing or already planned training products and services. All or some of the products (such as electronically based self taught training courses) may be useful, with or without being supplemented or modified. These costs can be forecasted and either planned for or avoided up front if review of available training products and services is performed as part of the market survey. By factoring this information into the life cycle cost forecasts for competing products, trade off decisions as to which product family is best for meeting all requirements, performance as well as supportability and cost, can be made.

In this second scenario, opportunity to become an additional user of existing training products and services is not available. Nonetheless, some training cost avoidance is possible. Often, open system interface standards based product development to meet unique military requirements represents repackaging or enhancement of products developed for other markets. In these cases, the training products and services associated with these other products may be modifiable for less cost than full development would imply. It is imperative that the ILS Manager, training development specialist, and cost analyst become familiar with the actual product development scenario envisioned by the bidders, the associated product families, and their existing training scenarios, products, and costs. Then comes the real challenge: determining the comparative anticipated costs. The tools available are information of typical training development costs and of the commercial marketplace, coupled with parametric analyses. Again, this is part of the market survey.

5.0 TOOLS, PROCESSES, AND METHODS

This section provides information on how some available acquisition related tools and processes can be used to create a cost effective and best value open system which embodies current technology over the entire service life. Listed below are tools and processes that are available to reduce program risk and enhance the probability of fielding and supporting an open systems product.

- Trade-off Study
- Market Survey
- Modeling and Simulation
- Test and Evaluation
- Configuration Management
- Warranty

Each of these tools are referenced by other sections of this Guide; thus, placing them in the context which allows them to be the most useful.

5.1 Trade-Off Studies

Trade-off is defined as "the determination of the optimum balance among system characteristics (cost, schedule, [22]. Trade-off studies are performed through out the life cycle of a product. The analysis is based on two basic data sources: market surveys (section 5.2); and, modeling and simulation (section 5.3). The market survey provides data on open system interface standards and products available as either non-developmental items (NDI) or commercial items. Modeling and simulation provides data as to potential architectural solutions using the various standards or NDI/commercial item products. The purpose of the trade-off study is to achieve a "best value" solution.

Commercially accepted open system interface standards provide several advantages which need to be considered in any trade-off study. These include:

- availability of a wider range of developers for initial product development, support, and upgrade;
- availability of NDI/commercial item products that satisfy ongoing supply support, functionality, or upgrade requirements increase as compiling standards, profiles, and products are further refined; and,
- similarity of commercial design practices and products may reduce the cost of developing technical documentation, training, and repair by making them more readily available and less costly to provide.

[22] James V. Jones, Integrated Logistics Support Handbook, TAB BOOKS Inc., 1987.

The purpose of trade-off studies is to maximize the open system environment (OSE) advantages in the new acquisition while achieving program objectives. Some trade-off study considerations are provided below.

TRADE-OFF STUDY CONSIDERATIONS
✓ Have all of the system performance requirements been achieved? • If not, can the shortfalls be mitigated? • Can the system requirements be modified? ✓ Have the system support requirements been achieved? • Is a commercial support infrastructure utilized? • On a product by product basis? • Does an organic support infrastructure need to be developed? ✓ In a legacy environment, consider partial or complete replacement of system or sub-systems. ✓ Pay to enhance support for product "A" or use product "B" which has full support but less performance. ✓ If a product is modified, will the DoD be the only user of the resulting product? ✓ Can repackaging make a product or interface feasible in the design?

The same considerations and questions should be asked throughout the acquisition program, especially when evaluating applications of selected products. The program office may not have to upgrade with each next generation of a product to meet the program's requirements. However, the program office should keep monitoring the products for conformance to standards, functional features, and performance capabilities. It is essential that the acquisition and logistics managers track the products to ensure the fielded components have not changed without notice. Trade-offs will be an ongoing effort with evolving standards and products.

5.2 Market Survey

With so many technologies and products for widespread commercial use by standards initiatives, technical and system architectures and product choices can, and must, be made on the basis of economic as well as technical merit.

The market survey is a critical tool in reducing programmatic and technical risks. The following table consists of questions typically addressed during a market survey. Some questions are more applicable to hardware than software. Some have metrics which can be assigned to some of them; others do not. The questions, metrics, and ranking as to importance should be tailored for program usage.

MAKET SURVEY CONSIDERATIONS
Maturity of Standards, Technologies, and Products ✓ How mature is the technology? • State of the art? • State of the commercial practice? ✓ Is the standard/profile tight enough to promote interoperability of compliant products? ✓ Are the products fairly stable? ✓ What is the product cycle time? ✓ When is the next scheduled product update? ✓ Are the products being refined or vastly changed at each cycle? **Market Acceptance**

MAKET SURVEY CONSIDERATIONS

- ✓ Are the standard(s), profile(s), and product(s) well accepted in the commercial marketplace?
- ✓ What is its market share?
    - Is it increasing?
    - Is it being outmoded?
- ✓ Is the commercial market big enough to imply long term support and upgrade of the item?

Multiple Product Sources

- ✓ Are there multiple sources for compliant products?
- ✓ Are the compliant products interchangeable with others that perform the same functions?
- ✓ Are the compliant products interoperable?
- ✓ Do they accept data from each other?
- ✓ Do they meet the same performance requirements?
- ✓ Are the products pin-for-pin interchangeable?
- ✓ Have the product interfaces been conformance tested?
- ✓ What were the test results?

Product Line Families

- ✓ Are there product families?
- ✓ Will usage of a given product commit us to a product family?
- ✓ Will such a relationship provide the best value?
    - Is the existing support structure well suited to the requirements?
    - Will it be required to supplement or replace existing support products (e.g., technical data, training, repair, upgrade, etc.)?
- ✓ Should the product family or the individual products be approved for system use?

Test and Evaluation

- ✓ How is the product tested?
- ✓ Is there existing test and evaluation data?
- ✓ What are the existing test and evaluation parameters?
- ✓ Does the existing test capability meet the needs?
- ✓ Does the existing test capability test families of products?
- ✓ How much will it cost?
- ✓ Have the product interfaces been conformance tested?
    - Does a conformance test capability exist for the product interfaces?
    - Is there existing conformance test data or certification?
- ✓ Is there existing reliability data?
- ✓ Will the government have to invest in test and evaluation facilities?
    - For integration?
    - For ongoing product support and/or upgrade?
- ✓ Does the standard(s) have a set of conformance test requirements/procedures?
- ✓ Do the conformance test procedures test for all mandatory requirements?
- ✓ Do the conformance test procedures address the optional and executable requirements?
- ✓ Does each product have conformance test data available?
- ✓ Are interoperability test requirements addressed or are they part of conformance test?

Technical Data

- ✓ Does the technical data currently exist?
- ✓ Is the technical data to be provided by the various suppliers sufficient?
- ✓ Is the technical repair documentation adequate?
- ✓ Is the data in a usable format? If not, what problems can be foreseen?

MAKET SURVEY CONSIDERATIONS

- ✓ Is the technical data available in an electronic format (e.g., Joint Continuous Acquisition and Life Support (JCALS))?
  - Who owns the data rights at the end of production?
  - Will the data be available after production?
- ✓ What work-around is available?

Configuration Management

- ✓ Does a configuration management baseline exist currently?
  - Is the data accessible on-line?
  - Are the latest designs documented and available?
  - Are the software version description documents available?
- ✓ Can it be worked around, modified or supplemented?
  - By the contractor or the government?
  - What will the cost be?
- ✓ When will this cost be borne?
- ✓ Does the contractor provide notification of product changes?
  - In time to make life of type buy as necessary?

Availability

- ✓ What is the operational availability (A_o)?
- ✓ What is the inherent availability (A_i)?
- ✓ What is the mean time between failure (MTBF)?
- ✓ What is the mean time to repair (MTTR)?

Performance Monitoring and Bit

- ✓ Is there Built-in-Test (BIT)/Built-in-Test Equipment (BITE)?
- ✓ Are the results accessible?
  - What is the BIT performance?
  - Are the self test capabilities acceptable from a system level view?
- ✓ Will it be hard to reintegrate when updates occur (not just from an engineering view, but also the support products and services, e.g., training, configuration status accounting, and supply support)?

Warranty

- ✓ Who will administer the warranty?
- ✓ Is an extended warranty available?
- ✓ What will the warranty cost?
- ✓ What is the original equipment manufacturer's (OEM) historical response to claims?
- ✓ When does the warranty begin?
  - On delivery?
  - On installation?
- ✓ Does the contractor (prime or integration) have existing repair agreements/warranties with the OEMs?
- ✓ Is the warranty(ies) transferable to the government?
- ✓ Are repair agreements available with the OEMs?

Quality Assurance

- ✓ Is the company ISO 9000 registered?
  - If not, does an acceptable quality process exist?
- ✓ What policies are in place for subcontractors?
- ✓ Are the subcontractors ISO 9000 registered?
  - If not, does an acceptable quality process exist?
- ✓ What is the company's reputation for quality of product?
  - For quality of support?

MAKET SURVEY CONSIDERATIONS
✓ What is the company’s record of prior performance on DoD contracts?

If the market survey determines that a NDI solution is unavailable, then a development program or some mixture of development and integration of commercial items will be necessary. Even in the purely developmental situation, the selection process of standards and profiles will drive system content toward specific technologies. These technologies have associated NDI products (e.g., interface chip sets) that directly affect the cost and supportability of the resulting system. These technologies and products should be evaluated to determine their supportability impacts on the system to be developed.

To the extent that NDI and commercial items are present within the system, those items must be evaluated in terms of usefulness in varied support environments as listed below:

- System design agent facility or development laboratory.
- System integration facility.
- Test and Evaluation facility.
- In-Service Engineering Agent/Cognizant Field Activity (ISEA/CFA).
- Software Support Activity (SSA).
- Installation and Checkout.
- Training.
- Fleet operation and maintenance.

Support requirements for each of these environments have unique and overlapping aspects which must be analyzed, planned for, and implemented. Based on analysis of requirements versus NDI support products and services, costs and schedules can be forecasted and compared.

An existing support product or service (e.g., technical consultation) may be well suited to some support environments but ill suited to others. For example, technical consultation services needed to enable the design agent to successfully utilize a product when designing a system are generally inappropriate to support the same product in a training or Fleet environment. The types of questions asked as well as the goals and pre-existing knowledge base of both the people asking and answering the questions are different. The documentation required probably overlaps, but is not the same.

The role of the supportability members of the market survey team is to determine what product support products (e.g., spares and technical manuals) and product support services (e.g., technical consultations and hardware repair) are available. Each must be evaluated against the support requirements of the environments listed above. Every program’s needs and opportunities will be unique.

For each requirement, available NDI/commercial item products and services should be identified, analyzed and evaluated. Where existing support products and services meet the requirements, anticipated usage scenarios and costs can be identified. When available NDI/commercial item support products and services will not meet requirements, the sources, schedules, and costs to supplement or develop future updates must be estimated. In most cases, estimated support costs for each product being considered can be determined and compared to that of its competitors. This information can generally be estimated based on inputs from the OEM and present customers. Thus support costs of different products can be used as a driving factor toward architectural choices based on an overall best value prior to commitment to a particular design architecture or product baseline. The pay off for the time and staff utilized for this effort is a best value system, an executable defensible program plan, and a solid basis for a Planning, Programming, and Budgeting System submission.

Personnel participating in the market survey can be drawn from the program office, ISEA/CFA, SSA, and other interested groups who know the usage environments and expectations. These personnel should have a stake in ensuring long term success of the effort.

Figure 5-1 provides a sample market survey format used for product evaluation. However, further evaluation and testing of the product should be performed to ensure it meets the open system interface standard profile. Considerations such as software maintenance, available product data, software configuration management processes, supportability, schedules, and other key issues as identified in the market survey form need to be evaluated.

PRODUCT SURVEY FORM					
PRODUCT		**REQUIRED HARDWARE ENVIRONMENT**		**LICENSING AGREEMENT**	
NAME:	RELEASE:	❑ IBM PC COMPATIBLE	❑ DEC		
VERSION:	RELEASE DATE:	❑ DEC VAX	❑ IBM S/3X, AS/400		
PRODUCT APPLICATION AREAS		❑ IBM S/370 (AND UP)	❑ IBM RISK 6000	**WARRANTY(IES)**	
❑ SYSTEM SIMULATION	❑ REQUIREMENTS TRACE	❑ SUN-3, 4 SPARC STATION	❑ HP APOLLO		
❑ REQUIREMENTS ANALYSIS	❑ TESTING	❑ HP 9000	❑ OTHER (SPECIFY)		
❑ COMMUNICATIONS	❑ QUALITY ASSURANCE	❑ APPLE MACINTOSH		**PRICE/COSTS**	
❑ LOGISTICS	❑ DATABASES	MEMORY REQUIREMENTS HARD DISK:		PRICE: $	MAINTENANCE: $
❑ DOCUMENTATION	❑ DESIGN	RAM:		UPGRADE: $	SERVICE CONTRACT: $
❑ METRICS	❑ PROJECT MANAGEMENT	I/O DEVICE REQUIREMENTS:		QUANTITY BUY: $ /	
❑ SOFTWARE ENGINEERING	❑ MODELING	**REQUIRED SOFTWARE ENVIRONMENT**		**USERS OF PRODUCT**	
VENDOR		❑ MS-DOS/PC-DOS	❑ SUN/OS	❑ NAVY	❑ AIR FORCE
NAME:	POC:	❑ OS/2	❑ VMS	❑ ARMY	❑ MARINE CORPS
ADDRESS:	PHONE:	❑ UNIX SYSTEM V	❑ IBM AIX	❑ OTHER (SPECIFY)	
EMAIL:	FAX:	❑ MICROSOFT WINDOWS SPECIFY	❑ IBM MVS, VM	**INSTALLATION**	
DEVELOPER DATA		❑ HP-UX	❑ OTHER (SPECIFY)	COMPLEXITY (1-10) ________	CONFIGURABILITY (1-10) ____
SIZE OF INSTALLED BASE:		❑ POSIX		**MAKE VS. BUY CRITERIA/ANALYSIS**	
FINANCIAL INFO:		NETWORK(S) SUPPORTED?	❑ YES ❑ NO		
		IF YES, SPECIFY:			
MARKET SHARE: ________%		**DATA TYPE AND FORMAT**			
PRODUCT OVERVIEW/DESCRIPTION		INPUT:	OUTPUT:		
				INHERENT RISKS	
		ARCHITECTURE (PRODUCT OPENNESS)			
		ARCHITECTURE TYPE:			
		API READ/WRITE CAPABILITY:			
		ADHERENCE TO STANDARDS: (IGOSS, GOSIP, etc.)			
		DATA FILE FORMAT AVAILABLE/DOCUMENTED:			
		PRODUCT/VENDOR SUPPORT			
		❑ ON-SITE	❑ ON-LINE HELP		
		❑ VENDOR SUPPLIED TRAINING	❑ TELEPHONE HELP LINE	**MEDIA USED FOR PRODUCT SURVEY**	
		❑ ON-SITE TRAINING	❑ USE GROUP ORGANIZED	❑ DEMO DISK(S)	❑ ON-SITE DEMO
		❑ OFF-SITE TRAINING	❑ NEWSLETTER AVAILABLE	❑ LITERATURE	❑ TRIAL PACKAGE
		❑ VIDEO TRAINING	❑ ELECTRONIC BULLETIN	❑ INTERVIEW	❑ VIDEO TAPE ON PRODUCT
		❑ COMPUTER-BASED TRAINING	❑ CONFERENCES	❑ USER EVALUATIONS	❑ OTHER SPECIFY
		❑ SOURCE CODE AVAILABLE	❑ S/W FIX BETWEEN RELEASES	**PERFORMED BY:**	**AGENCY PERFORMED FOR:**
		❑ VENDOR CUSTOMIZING	❑ S/W UPGRADES	POC:	
		❑ CUSTOMER CUSTOMIZING	❑ DOCUMENTATION UPGRADES		
INTENDED USE/APPLICATION		**UTILIZATION**		CODE:	
		❑ COPY DOCUMENTATION	❑ SITE LICENSE AVAILABLE		
		❑ EMBEDDED COPY PROTECT	❑ NETWORK VERSION	TELEPHONE:	
		❑ BACKUP COPIES ALLOWED	❑ WINDOW USER INTERFACE		
		❑ INTERACTIVE DEBUT	❑ GRAPHIC USER INTERFACE	EMAIL:	DATE:

Figure 5-1 Sample: Market Survey Form

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5.3 Modeling and Simulation

The need to speed the acquisition process, yet ensure reliable and supportable products are being fielded at best value, is at least partially met through use of modeling and simulation (M&S). M&S products and approaches have been used by the DoD for some time. Historically, M&S has been expensive, requiring a large and highly technical staff to first execute and then analyze and validate the results. An example is VHSIC Hardware Description Language (VHDL), used to simulate circuit board design and performance. DoD is now emphasizing use of M&S as a means to reduce time and cost of complex acquisition programs. The DoD plan for upgrading the process within DoD is provided in DoD 5000.59P, *Modeling and Simulation (M&S) Master Plan*, dated October 1995.

Faster and more complex computers have been fielded along with better software products allowing industry to apply these technological features to create M&S tools that are state-of-the-art. These tools can assist the program office to rapidly design and field products, often within 1.5 to 2 years from concept definition. Concurrent engineering goes hand-in-hand with the new M&S tools and the personnel who apply them.

Examples of how M&S may be used in the acquisition process to assess and resolve operational, system, and technical requirements are provided below.

OPERATIONAL ASSESSMENTS	SYSTEMS ASSESSMENTS	TECHNICAL ASSESSMENTS
• Operational Connectivity • Wargaming Assessment - Joint - Service • Logistics (Operational Support) • Training	• Performance • Inter/Intra-Connectivity • Interface Applications - Joint - Service - Changes/Impacts • Throughput • Contentions • Training • Logistics • Life Cycle Cost (LCC)	• Environmental Considerations • Performance • Design Feasibility • Interface Standards Considerations - Compliance - Conformance - Impacts • Form, Fit, Functionality • Training • LCC • Cost Realism • Changes/Impacts

M&S is used to model proposed interface standards and waveforms/protocols to determine interoperability factors and identify impacts, thus lessening the risks to go to production. Not only can M&S can be used to verify design consideration, but for DoD, it can be used early in an acquisition life cycle to do trade-off in terms of operational and system architecture impacts, especially if the target architectures have been baselined. M&S of communication network interface standards can identify connectivity capabilities and shortfalls, as well as impacts to architectural objectives.

M&S can be used to assess the feasibility of a design prior to prototyping. Modeling the design prior to prototyping can identify functional and physical disconnects, assess interoperability prior to building engineering development models or prototypes. M&S can simulate platform-to-platform configurations, cable installations, electromagnetic compatibility, and environmental considerations for platform type(s), etc. Additionally, the use of systems such as JCALS can help in timely distribution of the critical M&S data to those who need it.. Figure 5-2 provides examples of typical benefits that a program office can achieve using M&S in the acquisition of OSE systems.

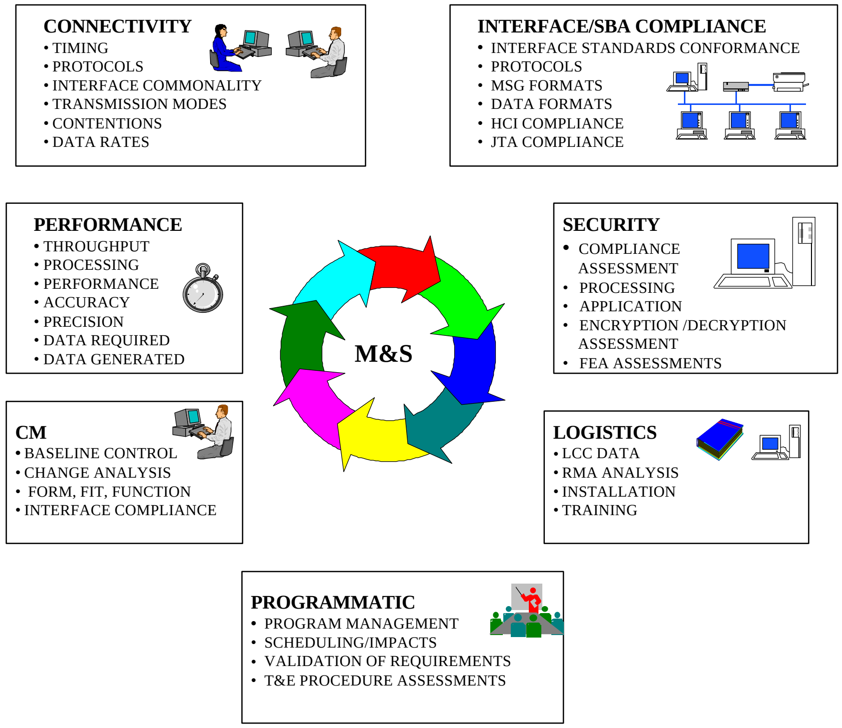

Figure 5-2 Typical Benefits From Applying Modeling & Simulation

5.4 Test and Evaluation

Open system interface standards foster use of rapidly changing hardware and software in DoD systems. The use of immature state of the art products and/or products that don't have underlying test data can result in increased testing needs. Strictly speaking, one could say that it is not open system interfaces, as such, that drive this need. If interfaces are well-defined, remain stable, and are adhered to scrupulously, products that make up higher assemblies and systems can be expected to work together. Costs associated with integration and operational testing would not be driven by interfaces. Unfortunately, it is quite common to encounter products which implement some but not all features (e.g., services) specified by a given standard and standard profile. Knowing which features within an interface standard and standard profile (mandatory and optional) are actually used is important. Equally important is whether vendor extension features (features defined outside the scope of a standard) are utilized (***caution***: allowing the use of vendor extensions often leads to a sole source relationship). Product choices as well as test planning and costs, will be affected. When processor, data transfer rate, computation or some other design factor affecting performance is changed, testing is needed to affirm the performance of the new item with other system components as well as it's conforming to interface specifications.

Choices of standards, technology, and actual products will impact test and evaluation (T&E) requirements (e.g., facilities and personnel) and cost. These costs should influence product usage decisions. See T&E considerations in the market survey section 5.2.

5.4.1 Testing Strategies

Strategies for test and evaluation of a standards-based product are an important acquisition concern. Conformance, interoperability, and performance testing provide valuable information about a product being acquired. The resulting information will reduce risk. Interface standards, profiles, and application product interfaces (APIs) must be exactly specified, or integration and other test (performance, conformance) costs will be dramatically increased. Products which do not meet advertised conformance and performance parameters cause integration and test to become more difficult, time consuming, and costly.

5.4.1.1 Conformance Testing

Conformance testing involves testing products to the requirements of an open system interface standard. Conformance testing leads to identification of any non-conformant behavior, including exception conditions such as error detection and recovery as defined in the standard. Conformance testing itself uses conformance test standards developed through, and approved by, independent standards bodies (i.e., ISO, IEEE, ANSI). Testing methods and requirements, defined in conformance test standards, are implemented on test equipment resulting in reusable test setups that provide repeatable results. That way, test results are traceable, via the appropriate conformance test standard, back to open system standard requirements.

During testing, test software exercises key product functions, which in turn exercise open system interfaces. Therefore, during conformance testing key product performance functions and the interfaces can be tested. Furthermore, as conformance testing relies on product documentation to setup and perform the testing, documentation accuracy is verified.

Conformance testing influences acquisition decisions by effectively screening potential products for the degree to which they meet interface requirements. The information gained through conformance testing is valuable during initial program development and product support, as well as during procurement of upgrades and technology insertions. When performing conformance testing of potential alternative products for upgrades, test results can be compared with those of the original equipment or software. Direct comparisons can be made only by using the same conformance test setup and identical application software to execute functionality during the testing. At that point the degree of upgrade compatibility with the original equipment can be determined. Testing in such a manner eases the integration of alternative products and upgrades into a system.

When possible, program offices should use open system interface standards that have established conformance requirements, procedures, and test facilities, (figure 5-3). This eliminates the need to develop those capabilities and the costs associated with them.

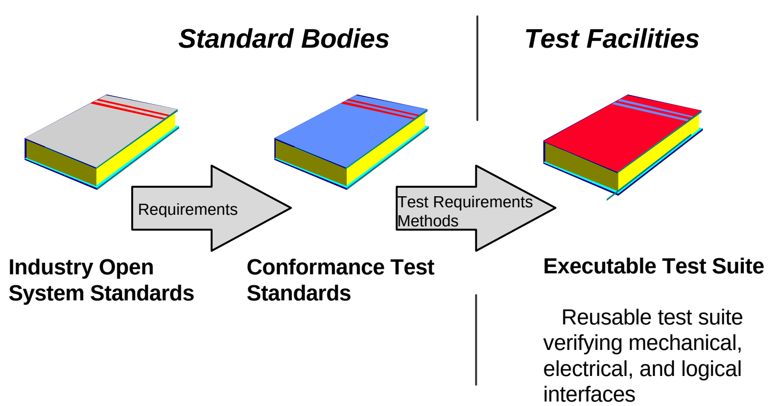

Figure 5-3 Conformance Test Development

5.4.1.2 Interoperability Testing

Interoperability testing involves the testing of two or more interface connected products for their ability to work together. Therefore, this testing examines the operation of interconnected interfaces. Interoperability testing does not necessarily include error handling and recovery tests nor does it provide any indication of products' ability to interoperate with products not part of the test set-up. Interoperability testing complements conformance testing as a predecessor to performance testing.

5.4.1.3 Performance Testing

In an open systems environment, performance testing includes parameters specified by the interface as well as those which are not (e.g., execution speed for a particular algorithm).

Interface performance criteria specified in a standard are verified during performance testing. Performance criteria not specified in an interface standard or specified as a range of values in an interface standard, also are measured. All testing of open system products should be considered part of the test and evaluation of an embedded system and therefore, should be included in the respective test and evaluation plans.

5.4.2 Testing Relationships

The purpose of accurately defining the standard profile of a particular standard is to enable application of that criteria for conformance and interoperability testing throughout the system life cycle. Figure 5-4 illustrates the relationship of testing where the program can:

- assess the conformance of a product to a specific standard,
- evaluate interoperability of two or more interconnected product interfaces,
- test a product to met specified performance requirements, and
- test whether the product can meet integration requirements.

Performance should be evaluated in terms of both the standard interface and the program's performance requirements. A product may not meet all the performance requirements specified by the standard or profile, but still be considered acceptable for the program's applications if the parameters it does meet exceed specified program objectives. If using the product means that other factors of consideration are not jeopardized and benefits can be achieved by using the product, then further testing and evaluation should proceed. For instance, a program office might consider using the product (that doesn't meet conformance requirements) if it meets program: performance, schedule, quality, and reliability factors; and, is a leader in cost effectiveness and supportability issues.

When the program office is planning for integration testing, sufficient data should be available from the other three testing efforts. This will ensure enough test data and conformance test information is on-hand to adequately plan and conduct integration testing efforts and assess the programs' overall integration risk factors.

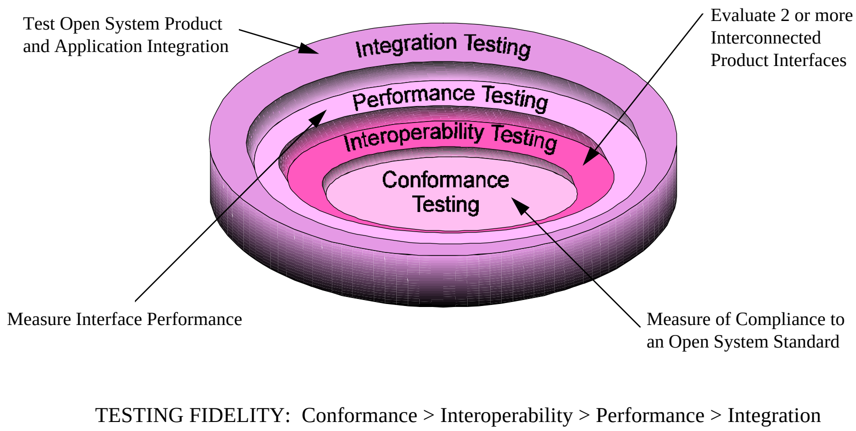

Figure 5-4 Open Systems Environment Related Testing

Part of the DISA and related TAFIM efforts is to identify standards and products which meet this criteria. The Navy and Air Force have similar on-going efforts and laboratories to test for conformance of some open system interface standards and products. As products emerge and industry and DoD establish a relationship in this area, more test facilities will become available. Test centers for open system interface standards such as VME, X-OPEN, FDDI, and others have been or are being established.

Implementation conformance refers to those products which have been verified and tested to meet the designated interface profile. Conforming hardware and software implementations may include a subset of features of the open system interface standard.

Conformance test efforts should enable the program office to determine if an implementation embodies the stipulated requirements of the standard and provide a metric to judge progress of the program towards and open system design. A result of conformance and interoperability testing is identifying the predictability of behavior and exception conditions of a product allowing the program office and integrated product team (IPT) to identify selected error conditions and fault detection/recovery capabilities. Reusable executable tests and procedures can be developed and a database for tracing test results to individual product can be maintained. The establishment of such a database will be important later in a program's life cycle when a product line updates or changes but still claims conformance to requirements.

5.5 Configuration Management (CM)

CM efforts are affected by the use of NDI, especially commercial items, and open system interface standards. CM, consisting of configuration identification, configuration control, configuration status accounting, and configuration auditing, is essential for definition and support of open systems. CM is an important tool used to facilitate acquisition, lifetime support, and upgrades to all systems.

Configuration management tasks are performed by designers, OEMs, integration contractors, and government program office and support activities. A majority of the support-phase configuration management workload falls on the program office or life cycle manager who must analyze needs and opportunities and must decide which changes should be made in the system. Test and evaluation, acquisition, and installation changes must be coordinated between all affected systems and documentation, including those at training activities, maintenance activities, and in storage throughout the life of the system.

5.5.1 Configuration Identification

ISO 10007, "Quality Management - Guidelines for Configuration Management",[23] defines configuration identification as "Activities comprising determination of the product structure, selection of configuration items, documenting the configuration item's physical and functional characteristics including interfaces and subsequent changes, and allocating identification characters or numbers to the configuration items and their documents."

It is suggested that commercial items and NDIs be identified using OEM labeling and numbering systems whenever possible. This avoids the complexity associated with correlating a labeling and identification system chosen by the program office, prime contractor, integration contractors, etc. with the OEM systems.

5.5.2 Configuration Control

Commercial standard ISO 10007 defines configuration control as "Activities comprising the control of changes to a configuration item after formal establishment of its configuration documents." Configuration control is essential for open systems, just as it is for proprietary systems.

The configuration control board (CCB) and interface control working group functions apply and are critical to effective management of commercial items, NDI, and developmental open system interface standard products. In both developmental and NDI/commercial item usage scenarios, interface profiles are a critical management tool with which to both record and manage interfaces.

The CCB is different for open systems which employ commercial items (hardware and software) because it is the OEM's interpretation of the market, not the government CCB, that determines which changes will be developed for those parts.[24] The CCB's role is then to evaluate and decide whether to implement each change as it becomes available from the OEM. Those implementation decisions are complicated by these factors:

- Many changes to commercial item are "nice but not necessary" for military systems, and thus invite rejection by the CCB. However, it takes only a short series of such rejections to produce a system that is dependent on antiquated (by marketplace standards) commercial items which are no longer supported by OEMs.

- Only standard product features should be routinely accepted for use. Only when necessary should the program office or CCB authorize "altered item(s)" since this will undoubtedly lead to a sole source proprietary (or at least a government unique) solution to the problem that doesn't afford the government the opportunity to leverage the commercial market for this product.

- Changes to hardware and software commercial items and NDIs should be tested before they are considered by the CCB, to ensure that the proposed change is fully functional and compatible with other portions of the system. The whole point of integration testing is to prove the functionality and

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[23] Many configuration management-related standards are available and in use by PMOs. Although the definitions in this section come from ISO 10007, the guidance is applicable to all open systems, including those that invoke MIL-STD-973.

[24] Although the PMO may not be able to *direct* changes to COTS or other NDI, as a customer the PMO can suggest changes to the OEM.

performance of the proposed change prior to introduction to the fleet. Interface (standards and profiles) conformance verification is part of the testing. This is particularly important if the system contains custom-built items, or if it contains older commercial items that are no longer generally used in the commercial market, since compatibility with those items will probably not have been included in the OEM's compatibility testing. If multiple versions of the system are deployed, compatibility testing should be performed with every system version that may receive the change.

- Many changes to software, particularly commercial software, require associated upgrades in other items, such as operating systems, memory, disk space, and processors. Installation of all of those upgrades must be carefully coordinated to ensure that the overall system remains functional. An accurate configuration status accounting system (section 5.5.3) is essential to achieving that coordination.

Unauthorized field upgrades or other changes are more likely to occur with open interface standards based systems. For example, if a ship's crew uses version 2.5 of a commercial database manager and version 4.0 is on sale ashore, there is some likelihood that someone will install the new product.

5.5.3 Configuration Status Accounting

ISO 10007 defines configuration status accounting as "Formalized recording and reporting of the established configuration documents, the status of proposed changes, and the status of the implementation of approved changes."

Use of a configuration status accounting system (CSAS) is critical for ongoing system support and upgrade. A CSAS should not only identify and track configuration items by OEM and part number but also by form, fit, and function in terms of a performance specification. Unless engineering and logistic support personnel know the *exact* configuration of each fielded system, the ability to maintain or upgrade that system will be adversely impacted.

The CSAS provides the data that enables the program office to identify acceptable alternate items and configurations. For example:

- To determine if a fielded system(s) need additional memory in order to accommodate a software upgrade.
- Whether a particular system can use a 500 watt power supply in place of the existing 300 watt power supply.
- How to restore functionality and performance to a system which has experienced failure of a hardware item which is no longer available.

Each of these examples are based on existing or new configuration baselines established through a formal change process.

5.5.4 Configuration Audits

ISO 10007 defines configuration audit as "Examination to determine whether a configuration item conforms to its configuration documents." Traditional audits are of two types, functional configuration audit (FCA) and physical configuration audit (PCA).

The requirements for performing configuration audits are not changed by an OSE. The level to which the audits are performed may not go to the piece part but rather only verify to the NDI/commercial item's (hardware and software) part number and revision (version) for configuration items. Altered items would be verified to the part number and revision and verify the alteration.

5.5.5 Commercial Configuration Management

As part of the acquisition reform effort, DoD and commercial entities will shift from military to commercial standards. User program offices will have to evaluate the manufacturer's implementation of CM and determine during the market survey (section 5.2) if it meets the program office's needs. If the market survey identifies that the manufacturers' configuration management is inadequate, consider the following:

ALTERNATIVE CONSIDERATIONS
✓ Can the government develop a work around for configuration management? ✓ Can the manufacturer modify or supplement its CM program to satisfy program office requirements? • Is the modification a no-cost modification? • Will the government be required to pay an additional cost?

5.5.6 CM by Form, Fit, and Function

CM by form, fit, and function is not a new concept. In the early 1970s, the standard electronic module (SEM) program was founded on the premise that a given function could be performed by the same module in a large number of locations (rack or box, unit, and system level). Since that time, technology has changed, bringing the ability to package more and more functionality on the same amount of real estate. Today, we see the same principle, that a given function can be performed by the same module in a number of locations, applied at higher levels of functionality, higher levels of integration. A good example is the Navy's tactical computers (TAC) program, whereby often times identical workstations can be used in a number of different system applications. Industry, of course, has been doing this for years. The ubiquitous personal computer is used for everything from making hotel reservations to controlling inventory and manufacturing processes. Today, open standards and profiles provide a framework which gets us part of the way to achieving interoperability, even interchangeability. Ideally, open standards and profiles would get us all the way, but, we presently deal with incremental progress toward that goal. Families of products, designed to meet form, fit, and function requirements (interfaces), generally function together to provide convenient pathways for system upgrade and maintenance. In each case, rules of what works together and what doesn't must be known and adhered to. In each case, product testing to determine and develop approved configurations, as well as actual configuration records, are needed to enable both product support and training of operator and maintenance personnel.

Form, fit, and function, by themselves do not equate to meeting all *performance* requirements. For each possible application of the computer resource product, there must be a record of:

- which configuration items are interoperable,
- which configuration items are interchangeable, and
- which software configuration items are usable with which hardware configurations.

This information will generally, but not always, be accumulated through testing. The need and extent of testing to be performed will vary. For example, changing from one 350 watt power supply to another which is identical in terms of form, fit, and function may not require any testing, unless, of course, the cooling fan supplied with one of the power supplies is less capable than the fan supplied with the other, and the unit in which the power supply is used tends to run hot, or is put in a hot place. Worse, two single board computers, perhaps from the same designer and manufacturer, may have different processors, or different amounts of onboard memory. The application software might or might not run at the same speed, or run at all. Information based decisions must be made as to the level of configuration management to apply to different system components. The information has to be kept up to date and provided as technical data to the people providing actual maintenance, supply support, technical manual development, upgrade, and training. A parts interchangeability matrix (PIM) can document this

information. Development and maintenance of the PIM requires people and facilities (often the same people and facilities who comprise the ISEA and SSA) to function as an ongoing design agent.

5.5.7 Commercial Markets and Rapid Product Evolution

Rapid product evolution increases the rate of change within our systems. Modern technology enables short product design to production times, often followed by short production runs prior to further product changes. As industry perceives possible market advantage through product evolution, the products change. Commercial market trends are influenced by opportunities to harness and improve technology, to develop and improve products for an expanding and changing marketplace. Our system design will, to one extent or another, follow commercial market trends. The higher the level of integration represented by an item (e.g., a chip versus a multi-chip module versus a card level product versus a box), the greater the probability that some of the components will not be the same from one production run to the next. DoD and our suppliers both face this problem. The major difference is the level of indenture. The challenge is to decide, in a timely manner, whether the same components are still available and are they still the best choice. These are CCB decisions resulting in product baseline changes, interchangeability data (e.g., the PIM), and changes to product support and upgrade planning. For each potential change, the following must be addressed:

ALTERNATIVE CONSIDERATIONS

- ✓ Is the change needed?
- ✓ Is the change avoidable, and if so, how?
    - Life-of-type buys?
    - Available substitutes from the same or other sources?
    - Wait for a later revision or product (use existing inventory for support)?
- ✓ Is the change cost effective (consider the alternatives)?

5.5.8 Configuration Change in DoD Systems

Reasons for configuration changes in government systems are numerous (figure 5-5). By using NDI/commercial items, the costs can be spread over other users of the same product. At whatever level NDI/commercial items are purchased, a CCB process must be used to decide on whether to accept changes made by others as well as whether to make a life-of-type buy, freezing on the previous revision. Particularly for a large system, the market survey, T&E, and CCB functions can easily become ongoing tasks. Possible and acceptable baseline changes and the ongoing technical data, product support, and training changes which follow them, imply a constant level of effort. This makes support and upgrade possible.

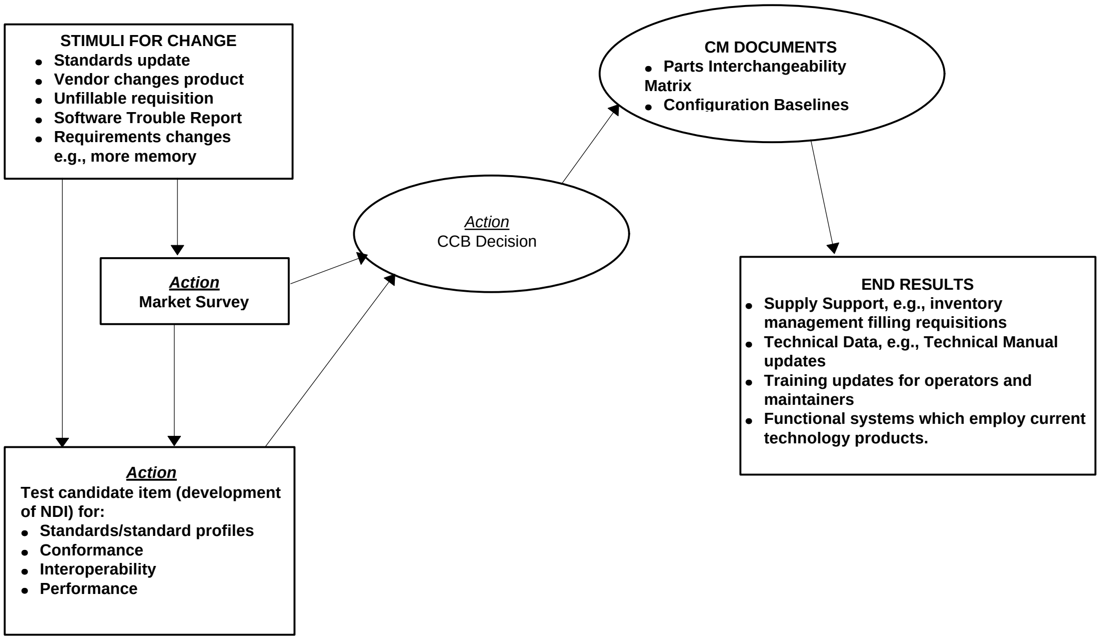

Figure 5-5 CM Centered View: Stimuli, Actions, Results

A given functional baseline may be represented by several product baselines. Accurate tracking of configuration data for rapidly evolving multiple baselines is necessary. Unless actual user system baseline information (configuration status accounting) is kept up to date, problem duplication/verification to enable maintenance support, upgrade planning, and training activities may become impossible.

Overall, CM efforts can be expected to increase. Considering the cost of CM activities, sometime they can be buried (hidden) by keeping the responsibility for CM with the prime or integration contractor.

5.5.9 Coping Mechanisms

The availability and type of data for CM can vary with each procurement (e.g., spares buy) and the degree of NDI/commercial item integration. System baseline control can still be adequately maintained, but the capability to control or actually make changes to a specific configuration item is not as readily available to the government. By applying electronic data transfer (e.g., JCALS) and by utilizing computer aided design/computer aided manufacturing (CAD/CAM), configuration control, tracking, and updating drawings can easily be accomplished, often at lower cost than in the past. Additional benefits include the availability of current drawings and the ability to transfer non-proprietary data to the program office. To gain these benefits, request for proposals (RFP) must require the bidders to adequately address CM. As part of an OSE CM process requirements and cost determination, some typical questions that should be addressed are provided below.

CONFIGURATION MANAGEMENT CONSIDERATIONS

- ✓ Have CM procedures and policies been developed and implemented?
- ✓ Are CM procedures and standards adequate?
- ✓ Has cost-effectiveness been considered?
- ✓ Are CM considerations being addressed during each milestone phase?
- ✓ Has the legacy system been analyzed in terms of interfaces?
- ✓ Are CM considerations being addressed as part of the market surveys? For example:
  - Is the product being evaluated under CM control?
  - Is computer-aided design/ manufacturing (CAD/CAM) available for current design?
  - Is vendor/producer change control in place and being implemented?
  - Is electronic data sharing (JCALS) available?
- ✓ Does the baseline information contain standards and standard profiles?
  - Are other performance parameters (e.g., Mb, access time, and processor speed) documented?
  - Is the contract documentation (including standard/profiles) mature, complete, and exact?
- ✓ If prime or system integrator is used, are mechanisms in place for CM control of vendors and/or subcontractors?
- ✓ Are mechanisms in place to identify changes to the program office when changes occur?
- ✓ When a change is proposed, are the following asked?
  - Is the change avoidable, and if so, how?
  - Will a life-of-type buy be required?
  - What will it cost?
  - Are substitutes available from same or other sources?
  - Is the proposed change essential or a nice to have function?
  - Have form, fit, and function considerations of a product been considered?
- ✓ Are changes to standards/profiles and products being monitored?
  - Is planning in place to gain advantage of changes to standards/profiles and products?
  - Is test capability in place to verify changes?

Necessary access to design and manufacturing configuration information may be easy to obtain from a product's source, or it may require actual inspection of incoming articles by the ISEA or other support personnel. No matter how the access is provided, the decision process, CCB action, and documentation, are still prerequisites to being able to provide effective product support.

A recommended practice is to create and maintain a PIM (table 5-1) for all hardware and software replaceable items. The PIM tells which items will function satisfactorily in each specific configuration of the host system. The PIM is a CM document, used by the support and upgrade practitioners. The PIM documents acceptable configurations of a system. Some sort of qualification or system testing is necessary as a basis for establishing and maintaining the PIM.

The PIM is a page based document, which can also be implemented as an electronic database. Each part gets it's own page. For each part, data fields interact, providing a picture of what can be used to replace the item, and what if any other changes (e.g., software) will be needed. The data fields are self explanatory.

Part Number	Interchange-able With	Usable With Baselines	Other Hardware Items Required	Applicable Software Version	Notes
123	123-1 123-2	(V)6		6R1	Original baseline Technical Manual (V)6
		(V)7		7R4	Technical Manual (V)6,7
		(V)8	125-3 126-4	8R0	Technical Manual (V)8
Predecessor					
Upgradeable To					
123-2, 123-3					

Table 5-1 Parts Interchangeability Matrix Example

5.6 Warranty

Although warranties are not unique to the open system architecture approach to obtaining systems, warranties are paramount to receiving quality products under a open systems based contract.

5.6.1 Commercial Warranty Utilization

Warranty coverage is required under 10 USC 2403 whenever unit cost is greater than $100,000 or the total procurement exceeds $10,000,000. The warranty assures the government that:

- The item meets structural and engineering plans and conformance with manufacturing particulars.
- The item is free from defects in material and workmanship at the time of delivery to the government.
- The operating capabilities or maintenance and reliability characteristics of the item meet those required to fulfill military requirements.

Conformance to design and freedom from defects are traditionally covered under the inspection clause of the contract. The operating capabilities or maintenance and reliability characteristics of the item may be addressed through either an incentive warranty or an assurance warranty.

An incentive warranty provides incentives for the contractor to exceed minimum design, quality, or performance levels. For such a warranty, the contractor can adapt a strategy to merely meet the minimum performance levels. However the warranty should be structured so that the risks of failing to achieve the minimum levels, or the profit associated with exceeding those levels will induce the contractor to exceed minimum levels. This type of warranty does not necessarily meet the requirements of 10 USC 2403.

An assurance warranty is the type of warranty used when the primary intent is to assure that minimum design, quality, and performance levels are achieved. In an assurance type warranty the contractor is responsible for damages or for repair of items failing during the period of the warranty. Assurance warranty remedies:

- Redesign. If a defect pertains to the whole population, the warranty terms may stipulate a redesign and replacement of the defective component. This is similar to an automobile recall.

- Price adjustment. In some cases, correction of a defect may not be possible or practical, and the only remedy available may be to "equitably" adjust the contract price downward. in this sense, the amount of the adjustment must be commensurate with the damages suffered by the government. An example of such adjustment is the logistics support cost (LSC) guarantee (LSCG). If a measured LSC (MLSC) is greater than the corresponding guaranteed value the contractor may have to "pay" all or part of the difference through a downward adjustment in the contract price. On the other hand, the contractor may share some or all of the potential savings if the MLSC value is lower than that guaranteed. It should be pointed out that the term "equitable adjustment" is relative, the contractor's perception may differ markedly from that of the government. Conceptually, the term sounds much more benign than the process proves in reality.

- Repair and replacement. This closely matches the common perception of warranty in which a defect may be corrected through a repair or replacement action. Typically, such a remedy would be applied to an individual-system defect as opposed to a population defect. If the contractor performs the repair or supplies the replacement, there is no additional cost to the government; if the government performs the repair or supplies the replacement, it may bill the contractor. The term "bill back" is used to describe this remedy. The amount or the method by which the amount is determined is generally specified in the contract. Normally bill back amount cannot exceed the contractor's normal repair and replacement costs.

5.6.2 Warranty Example

SPAWAR is currently testing a method for processing the "repair and replacement warranty" through the supply system using normal Military Standard Requisitioning and Issue Procedures (MILSTRIP) and Military Standard Transaction Reporting and Accounting Procedures (MILSTRAP) procedures and administratively shifting the burden of warranty management from the user to the supply system. The following conditions apply:

- The warranty period is for the life of the contract, that is, all items and repair parts procured under the contract have the same warranty expiration date.

- The government contracts the right to repair (e.g. remove and replace failed components) the hardware using government labor without voiding the warranty provisions.

- The contractor agrees to ship replacement parts without billing the government for up to 60 days while awaiting receipt of the failed warranty part.

- The contractor and the government enter into a just-in-time (JIT), electronic data interchange (EDI) purchase order arrangement for supply support.

- The government waives its right to contractor on-board repair for the convenience of the government.

5.6.3 Warranty Procedures

Provided below are warranty procedures:

- The Navy Inventory Control Point (NAVICP), formally the Ships Parts Control Center (SPCC), assigns a 7 Cog stock number to repair parts under this contract requiring the failed part be returned.

- The NAVICP lists the vendor and contract number for these items in the master reparable items list with a note to include the serial number of the component on the turn in document.

- The NAVICP establishes a standard price based on the cost of the item plus SPCC surcharge and a net price based on the SPCC surcharge only.

- The requiring activity, using normal MILSTRIP procedures, transmits a funded requisition to NAVCIP who procures the item from the vendor using established JIT/EDI procedures using net price when the failed item is available to be returned to the vendor and standard price if unavailable or damaged by the government.

- The requiring activity returns the failed item via the advanced traceability and control (ATAC) hub within the 60 day window.

- The vendor screens the material for warranty eligibility and reports exceptions back to the government for resolution.

- The NAVICP bills exceptions back to the requiring activity if the exception was caused by activity negligence or if the requiring activities does not return the failed warranty components.

The procedures delineated above were developed with certain criteria in mind. The criteria are:

- the warranty process needs to be invisible to the user, meaning that no extra effort would be required from the user to process the items that fail under the warranty,
- the supply system is to be used to replace the parts that fail ensuring historical data for post-warranty operations,
- the proper billing and crediting procedures need to be included as user incentives to take advantage of the warranty and use the NAVICP for requisitioning parts, and
- the procedures are developed to utilize existing NAVICP systems, as program changes are lengthy and may impose additional burdens on the fleet.

APPENDIX A LIST OF ACRONYMS

A_i	Inherent Availability
AIS	Automated Information Systems
ANSI	American National Standards Institute
A_o	Operational Availability
API	Application Program Interface
APL	Allowance Parts List
ASTM	American Society for Testing and Materials
ATAC	Advanced Traceability and Control
ATM	Asynchronous Transfer Mode
BEA	Boundary Element Analysis
BIT	Built-In Test
BITE	Built-In Test Equipment
C/S/A	CINCs/Services/Agencies
C3I	Command, Control, Communications, and Intelligence
C4ISR	Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance
CAD	Computer Aided Design
CAIV	Cost as an Independent Variable
CALS	Continuous Acquisition and Life Support
CAM	Computer Aided Manufacturing
CBT	Computer Based Training
CCB	Configuration Control Board
CCITT	International Telegraph and Telephone Consultative Committee
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CFA	Cognizant Field Activity
CFS	Center for Standards
CGM	Computer Graphics Metafile
CID	Commercial Item Description
CINC	Commander in Chief
CISA	C4ISR Integration Support Activity
CM	Configuration Management
CMS2	Programming Language
CSAS	Configuration Status Accounting System
CSCI	Computer Software Configuration Items
DAB	Defense Acquisition Board
DFAR	Defense Federal Acquisition Regulation
DII	DoD Information Infrastructure
DISA	Defense Information Systems Agency
DoD	Department of Defense
E&MD	Engineering and Manufacturing Development
EA	Evolutionary Acquisition
EC/EDI	Electronic Commerce, Electronic Data Interchange
ECP	Engineering Change Proposal
EDI	Electronic Data Interchange

FCA	Functional Configuration Audit
FEA	Finite Element Analysis
FIPS	Federal Information Processing Standard
GOSIP	Government Open System Interconnection Profile
GOTS	Government Off-The-Shelf
GUI	Graphical User Interface
HWCI	Hardware Configuration Item
I/O	Input/Output
IAP	Integrated Architectures Panel
ICP	Inventory Control Points
IEEE	Institute of Electrical and Electronics Engineers
IER	Interface Exchange Requirements
IGES	Initial Graphics Exchange Specification
ILS	Integrated Logistics Support
IPPD	Integrated Product and Process Development
IPT	Integrated Product Team
ISEA	In-Service Engineering Agent
ISO	International Organization for Standards
IT	Information Technology
ITF	Integration Task Force
J6	Joint Level
JCALS	Joint Continuous Acquisition and Life Support
JCS	Joint Chief of Staff
JIT	Just-In-Time
JMA	Joint Mission Areas
JROC	Joint Requirements Oversight Council
JTA	Joint Technical Architecture
LAN	Local Area Network
LCC	Life Cycle Cost
LOR	Level of Repair
LORA	Level of Repair Analysis
LRU	Lowest Replaceable Unit
LSA	Logistics Support Analysis
LSC	Logistics Support Cost
LSCG	Logistics Support Cost Guarantee
M&S	Modeling and Simulation
MAPP	Master Acquisition Program Plan
MILSTRAP	Military Standard Transaction Reporting and Accounting Procedures
MILSTRIP	Military Standard Requisitioning and Issue Procedures
MLSC	Measured Logistics Support Cost
MNS	Mission Need Statement
MOTU	Mobile Technical Unit
MTBF	Mean Time Between Failure
MTTR	Mean Time to Repair

NATO	North Atlantic Treaty Organization
NAVICP	Navy Inventory Control Point
NAVSEA	Naval Sea Systems Command
NAVSUP	Navy Supply Systems Command
NDI	Non-Developmental Item
NEC	Navy Enlisted Classification
NGCR	Next Generation Computer Resources
NIST	National Institute of Standards and Technology
NMCS	National Military Command System
NPS	Naval Postgraduate School
NW	Network
OASD	Office Assistant Secretary Of Defense
OEM	Original Equipment Manufacturer
ORD	Operational Requirements Document
OSA	Open System Architecture
OSE	Open Systems Environment
OSJTF	Open Systems Joint Task Force
PCA	Physical Configuration Audit
PDES	Product Data Exchange using STEP
PDR	Program Design Review
PIM	Parts Interchangeability Matrix
POE	Projected Operational Environment
POSIX	Portable Operating System Interface
PPBS	Planning, Programming, and Budgeting System
PSA	Principal Staff Assistant
PTD	Provisioning Technical Documentation
QA	Quality Assurance
QM	Quality Management
R&D	Research and Development
RFP	Request for Proposal
RMA	Reliability/Maintainability/Availability
ROC	Required Operational Capability
SAA	Systems Application Architecture
SBA	Standards Based Architecture
SCN	Specification Change Notice
SDR	System Design Review
SEI	Software Engineering Institute at Carnegie-Mellon University
SEM	Standard Electronic Module
SGML	Standard Generalized Markup Language
SLOC	Source Lines of Code
SOO	Statement of Objectives
SOW	Statement of Work
SPCC	Ships Parts Control Center
SQL	Structured Query Language
SSA	Software Support Activity
STEP	Standard for the Exchange of Product Model Data
SYSCOM	Systems Command

T&E	Test and Evaluation
TAC	Tactical Computers
TAFIM	Technical Architecture Framework for Information Management
TCP/IP	Transmission Control Protocol/Internet Protocol
TEB	Technical Evaluation Board
TEMP	Test and Evaluation Master Plan
TPS	Test Program Set
TRM	Technical Reference Model
USD(A&T)	Under Secretary of Defense for Acquisition and Technology
VHDL	VHSIC Hardware Description Language
VID	Vendor Item Drawings
VME	Versa Module Europe
WAN	Wide Area Network
WWW	World Wide Web

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